THE STUFF THAT BINDS: ON THE NATURE AND ROLE OF INFORMATION IN MILITARY OPERATIONS

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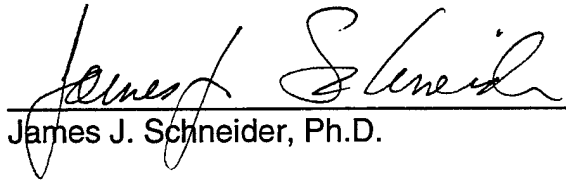
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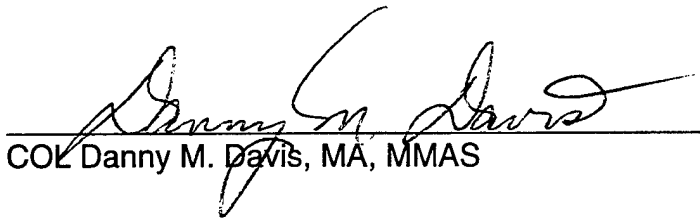
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ABSTRACT

TITLE OF THE MONOGRAPH: *The Stuff That Binds: On the Nature and Role of Information in Military Operations* by MAJ Joseph A. Brendler, USA, 59 pages.

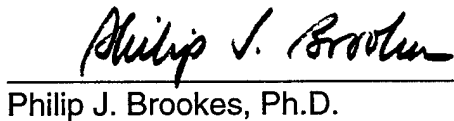This study assesses the validity and general utility of metaphors used in military theory and doctrine to describe the nature and role of information in military operations.

The monograph is an extension of the author's earlier work (*Physical Metaphor in Military Theory and Doctrine: Force, Friction, or Folly?*). The analytical framework is built upon the curriculum of the Advanced Military Studies Program, US Army Command and General Staff College at Fort Leavenworth, KS. The advice of experts is integrated through a review of scholarly works on human communication, cognition, organization, decision, and complexity. A critical review of these theoretical foundations is provided as appendices and summarized in the basic document. Finding no single "best" metaphor, the author presents a revision of the US doctrinal cognitive hierarchy and an extension of J.F.C. Fuller's Foundations of the Science of War. This provides a unified system of thought in which the correspondence between the various metaphors is apparent. The extension of Fuller's work results in the generation of core functions which reconcile the different perspectives on information and other more familiar aspects of military activity as well.

The study has shown that "Information Superiority" is currently a bad metaphor because it considers only the informative nature of information, ignoring the affective nature; it promotes inappropriate aggregation of functional proponents in an "IO cell;" and it promotes a "bit count" mentality. "Commodity" is a good metaphor whose most useful feature is perhaps the good correspondence it enjoys with the newer, more complex metaphors, thus making it a good tool for explaining them. "Social Glue" is a good metaphor that is somewhat abstract and cannot completely describe the nature and causes of moral bonding, but it corresponds well with other metaphors. "Catalyst" is a pretty good metaphor that is somewhat superficial, but it helps to describe the dynamic nature of organizations that the "social glue" metaphor cannot. "Medium as Message" is a good metaphor, but it is relatively abstract and complicated, is not well known and understood, and as a result, it is unlikely to be of direct utility for communicating with the average layperson. "Core Function" is an excellent metaphor-set that corresponds well with each of the other metaphors described, but it also uniquely adds a correspondence to other aspects of military operations and to the principles of military operations that other metaphors do not. Some of the other metaphors are better at describing specific perspectives, but these *core functions* are the basis of a coherent system of thought. As such, they provide a uniform perspective from which to enable the reconciliation of apparent differences between the other models of the nature and role of information in military operations.

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INTRODUCTION

[Once, a group of] blind men [was trying] to discover the nature of the elephant: the one who touched its leg called it a tree, another who touched its tail called it a rope, and so on... Is a good definition possible? Does having one matter? Perhaps there is no elephant, only trees and ropes that aspire to become one... the slippery inference derived from loose aggregation points to the conclusion that the United States can and must seek the dominance in information warfare it currently enjoys in air warfare, as if these arenas were comparable.[1]

Martin C. Libicki, *What is Information Warfare?*

"Information" has become an item of increased relevance in recent doctrinal development because of several continuing trends. "Information" is not a new term, nor is its use in warfare a new phenomenon. However, backed by rapid advancement of information processing and communication technologies, the *ways* in which individuals and groups *use* "information" and the way people *think* about it is changing. So, the meaning of the word "information" has become rather imprecise. Further, the basic term has been joined by a host of directly associated labels: "information warfare," "information operations," "information dominance," "information system," "information infrastructure," "information overload," and so on. These are also accompanied by secondary or indirectly associated terms like "command and control (C2) warfare," "C2 attack," "C2 protect," "psychological warfare," "cybernetic paralysis," and so on. These terms have even less precise meaning than their root, and this has made them the subject of many debates.

This condition has been exacerbated by the tendency in western culture to see apparent contradictions as dichotomy. Examples are the traditional conflicts between science and art, logic and intuition, reason and passion, and so on. Dealing with these dichotomies, central to the debates mentioned above, has made them even more contentious and confusing. A further source of confusion is the lack of a *common* set of

principles with which to consider the roles of information *and* the other more familiar aspects of military operations. However, the world continues to change – whether the military community understands the change or not.

So meanwhile, as academics debate, practitioners develop techniques and procedures. For instance, the US Army and the joint military community have begun a practice of "information operations" (IO) that is centered on an ad hoc planning group called an Information Operations Planning Staff, or "IO Cell".[2] This staff coordinates the consideration of all aspects of "information operations."[3] This indicates the current mental construct in which "information operations" is a single function that is distinct from the others that military units perform. However, the activities supervised by this ad hoc staff are embedded in the routine activities of the subordinate units performing the parent unit's other battlefield functions. This seems to imply that a decentralized approach to "information operations" would be more appropriate. Libicki hypothesizes that such centralization and glamorization of information related activities are a response to the uncertainty that comes with the "newness" of evolving thinking. "If understood correctly, information warfare loses its sex appeal... but it would grow up and go to work."[4]

So which approach is right? Should staffs centrally consider all aspects of information "top-down" or should information techniques and procedures be built into military doctrine, organization, and training "bottom-up," or both? The answer to this and many other questions depends on the military's collective conceptual understanding of the *nature* and *role* of information. In the long run, this understanding will have a profound influence on the future form and function of the military. In fact, many have

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claimed the existence of a revolution in military affairs because of the scale and scope of the impact of these concepts, but the authors of military theory and doctrine are still struggling to explain them. These authors are faced with a formidable challenge: Because some of the concepts are new and complex, the authors themselves cannot be expert in all aspects. These concepts are therefore *doubly* difficult to articulate to an essentially lay-readership. In response to this challenge, writers assemble their works with the tool they use for linguistic innovation: the time-honored tool of metaphor.

In a December 1997 monograph entitled *Physical Metaphor in Military Theory and Doctrine: Force, Friction, or Folly?*, the author describes how metaphor can be good, or it can be bad, depending on the application. Good metaphor serves two basic purposes in explaining military theoretical concepts, but these purposes contend with one another. First, good metaphor is simple enough to provide a layperson with an intuitive understanding. Second, it is accurate and precise enough in its representation to serve as a proxy model. Bad metaphor, which results from violation of either of these rules, serves to the detriment of any professional community. The body of contemporary military theory and doctrine is replete with metaphor, and it enjoys the beauty and simplicity imparted by the good, and it suffers the inelegance and confusion imparted by the bad.

Metaphor can be a powerful enabler of informative or persuasive communication, but it can also be dangerous. On one hand, a speaker can "translate" meaning to a listener of generally dissimilar background by expressing it via metaphorical reference. This reference elicits the use of some common experience as a basis for judgement. "Old words" grow "new meanings." In this way, metaphor allows the language to adapt and

evolve as the environment changes. On the other hand, the very creation of "new meanings" for "old words" reduces the precision of the words. This is a sort of "degeneration" of language. Eventually, the "old words" can lose their utility as readers find it increasingly difficult to determine precisely what they mean.

One important function of military theory and doctrine is to keep the common language of military professionals fresh and precise – to keep collective military thinking coherent. Theory introduces new concepts, often through the use of metaphor. A formal staffing and approval process generates new doctrine. This new doctrine is the authoritative basis for common action. For this reason, authors of doctrine must exercise rigor and precision in their choice of metaphor. If they do not, doctrine will become degenerate and lose its ability to provide a coherent system of thought leading to common action.

If readers cannot learn the new concepts and distinguish between the reality and the thing it is like – between the subject and the object of the metaphor -- then the metaphor is bad. As Martin C. Libicki says in *Defending Cyberspace and Other Metaphors*:

> Used properly, a metaphor can be a starting point for analysis, a littoral, as it were, between the land of the known and the ocean of the unfamiliar... But before analysis proceeds... *metaphors must be put back into the box from whence they came so that issues can be understood for what they are, not for what they look like.* To use metaphor in place of analysis verges on intellectual abuse. It invites the unquestioning extension of a logic that works across the looking glass but lacks explanatory power in the real world.[5]

In *Physical Metaphor in Military Theory and Doctrine*, this author developed a framework for analysis and a set of evaluation criteria with which to judge the fidelity and general utility of metaphors used in military writing. Using that work as a starting

point, this monograph will be a search for good metaphor describing the nature of information and its role at the operational level of warfare.

Like the work of Libicki, this effort strives to separate what information *is* from what it *resembles* and from what it simply *is not*. However, Libicki focuses on "information warfare" – where he calls "warfare" a metaphorical description of the use of information by adversaries in some sort of conflict that is not necessarily war, but resembles war.[6] Thus, Libicki's scope includes many non-military actors and organization well above the operational level. This monograph focuses within the scope of military operations on *information itself* – where metaphorical descriptions of its nature and role at the operational level reveal the structure of military thinking. This monograph is a critical analysis of that thinking.

ISSUE STATEMENT AND METHODOLOGY

STATEMENT OF THE BASIC RESEARCH QUESTION

> *Does contemporary military theory and doctrine have a single good metaphor with which to explain the nature of information and its role in military operations or are there several? If several, how can they be unified in a system of coherent thought?*

RELATED RESEARCH QUESTIONS

> *What is metaphor and what is its role in communication?*
> *What does "information" mean?*
> *How is information used in physical, cybernetic, and moral domains?*
> *How SHOULD it be used?*
> *What metaphors do military authors use to describe information and its roles?*
> *Is there a single best one? If not, how can the several be unified in a system of coherent thought?*

METHODOLOGY

The goal of this monograph is first to find a new way to *think* about the question and second to find a way to *think* about the many different answers – a way in which the differences between these answers are not seen as irreconcilable contradictions or

dichotomies. A good metaphor or a set of good metaphors in a system of coherent thought could provide access to that way of thinking. However, in order to be able to judge the utility of metaphorical candidates, one must first understand the subject.

Therefore, the monograph is initially an articulation of some very general concepts, but space and time do not permit complete examination of all regions related to the basic question. So, the THEORETICAL FOUNDATIONS are summarized in the basic document. Appendix 1, a full exploration of these theoretical subjects, is provided for the reader interested in more detail.

The first part of THEORETICAL FOUNDATIONS summarizes the role of metaphor in military writing. This serves two purposes. On one hand, it explains how metaphors "work." On the other, it uses metaphor as a prototypical form of information and communication to introduce several of the fundamental concepts in a "working" context. Next, THEORETICAL FOUNDATIONS summarizes models explaining the nature and role of information and communications in contemporary general literature. The relevant vocabulary is introduced and arranged in a coherent framework. The next section of the monograph is a PRELIMINARY HYPOTHESIS that suggests how one might overcome the mental handicap of dichotomy and reconcile the differences in good metaphors. With this framework in place, the study becomes an examination of military literature. Then, using an established set of evaluation criteria, the DATA, METHOD, AND ANALYSIS section provides a critical analysis of the metaphor found in selected doctrinal publications and the writing of selected military commentators. These evaluation criteria determine whether the metaphors examined are "good." They

determine the fidelity and general utility of the metaphor. After evaluation, the good

metaphors are compared and reconciled in a system of coherent thought.

SUMMARY OF THEORETICAL FOUNDATIONS

> *And the priestess spoke again and said: Speak to us of Reason and Passion. And he*
> *answered saying: Your soul is oftentimes a battlefield, upon which your reason and your*
> *judgement wage war against your passion and your appetite. Would that I could be the*
> *peacemaker in your soul, that I might turn the discord and rivalry of your elements into*
> *oneness and melody. But how shall I, unless you yourselves be also the peacemakers,*
> *nay, the lovers of all your elements? Your reason and your passion are the rudder and*
> *the sails of your seafaring soul. If either your sails or your rudder be broken, you can*
> *but toss and drift, or else be held at standstill in mid-seas. For reason, ruling alone, is a*
> *force confining; and passion, unattended, is a flame that burns to its own destruction.*[7]

> *The Prophet*, Kahlil Gibran

Appendix 1, which is summarized below, provides a full exploration of the

theoretical foundations of this monograph. It is essentially a critical review of the

literature. It begins with a synopsis of the author's earlier work, of which this monograph

is an extension. Then it establishes a general framework for consideration of the research

question. Next it reviews several of the various perspectives that respected authors use to

look at the question and attempt to answer it. Finally, since there is no single, satisfactory

answer in the literature, J.F.C. Fuller's *The Foundations of The Science of War* is

reviewed as a possible method for establishing integrative principles.

METAPHOR IN MILITARY THEORY AND DOCTRINE

A metaphor is a word or phrase that is used to represent a concept for which other

words or phrases are not sufficiently definitive.[8] Metaphor makes it possible for a

listener to share an understanding of something despite a lack of direct experience with it.

Understanding comes from familiarity with the surrogate – the metaphor. Such literary

construction is often necessary in the creation of new paradigms for military theory and

doctrine. Metaphors become, so to speak, the mental "super models" that enable the

development of shared meaning regarding the new concepts. However, metaphors also have a dark side. The very act of using a word to mean something else tends to decrease the precision of the word's meaning. So authors must use them carefully.

Metaphors are an example of affective communication. They carry an *affective* power to influence one's emotional state and facilitate values-based judgement beyond that provided by their purely *informative* content.[9] The informative content of communication promotes the rational aspects of cognition and judgement, but it cannot promote intuition. Affective communication, on the other hand, promotes the use of non-rational faculties in the catalyzed development of justified beliefs (knowledge).

INFORMATION, COMMUNICATION AND DECISION-MAKING

Interestingly, people usually believe their judgement to be purely rational, but it is not.[10] This makes the choice of good metaphor an important concern of military authors. More importantly though, the same not-entirely-rational faculties guide military decision-making under uncertainty. As decision-strategist Ronald N. Giere illustrates in appendix 2, people decide when and *how* to decide-under-uncertainty based on the *values* they associate with the information they have about the possible outcomes and the actions potentially required. These values determine whether the decision-maker opts to "play it safe," "gamble," or use a "rationalist strategy."[11] The difference between good decision-making under uncertainty and bad is the justifiability of the decision-maker's beliefs regarding the relationship between actions and outcomes. Justifiability is based on a *value judgement*. This, in turn, depends on the availability of sensory and communicated information that both *informs the reason and affects the intuition*. As detailed at appendix 1, current military doctrine describes the role of information in a cognitive

hierarchy that includes only the rational half of the process described above.[12] It is fairly

complete in its consideration of the *cognitive domain* but not in its consideration of the

affective domain.[13]

Military problem-solvers combine these faculties to cope with situations in a way

that is beyond rational. Also, the collective normalization of value systems fosters the

commitment and motivation that generates moral cohesion. Both of these abilities are

critical to leaders. ***Commanders provide affective communication to motivate and***

maintain cohesion, and they receive affective communication to solve problems under

uncertainty.

Appendix 1 provides a classical generalized model of the communication process.

This model includes the traditional linguistic features of symbols, signs, encoding, and

noise. It also connects these concepts to the notion of affective communication as a

feature of cognition. However, this model does not fully explain the *role* of

communication in military organization.

There are several general types of communication. ***Interpersonal***

communications occur between individuals. ***Governmental social extensional***

communications occur between controlling or governing authorities – like commanders –

and their subordinates. These communications extend authority in order to regulate or

control the behavior of groups – like military units. ***Sensory observation*** is not

technically communication since it involves only one intelligent party. However, there are

aspects of reconnaissance, surveillance, and target acquisition systems that resemble both

observation and communication (if an intelligent enemy is the object of observation).

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Therefore these are called *hybrid* systems in this monograph. See appendix 1 for more detail.

There are also several general metaphorical models of information and communication that explain different aspects of what the terms mean. The first model, classical information theory, is called the "Meaningless Model" in this monograph. Its adherents consider information to be a primitive physical concept. This is the way mathematicians think about information, but by itself this concept has little practical value in typical military operations. However, it derives from something that does – for practical purposes, the physical "information" itself is *about* something. The **information is a physical ordering of something in space and time to represent the ordering of something else.** Information is normally stored as spatially ordered symbols – like in a computer – and it is transmitted as temporally ordered symbols – like over a telephone line. This concept connects information to the physical reality it represents. Information *represents* actors and objects in the environment and the interactions between them. However, it still does not necessarily convey what that physical reality *means.*

The second model is the "Economic Model." This model treats *information as a commodity*. The economic model provides some good insights and is quite prevalent in US Army doctrine, but it tends to restrict one's thinking to the cognitive or cybernetic domain. It does not adequately consider the *role* of information and communication in organizations. The next model does this better.

The third model is Marshall McLuhan's notion of communications media.[14] McLuhan's "Hot" media are "high definition," "cool" media are not. Hot media provide for affective communication and leave little requirement for active "participation" in

cognition and judgement. Cool media, on the other hand, require participation in cognition and judgement. Hot media promote changes in societal organization. Cool media promote organizational stability. Introduction of faster media also promotes centralization. However, if the faster medium is not universally available, then diversity in organization results. Military organizations use media of each type. For example, telephone is a cool medium, and radio is a hot medium. Video Tele-Conferencing (VTC) is a hot and fast medium. It also provides faster transmission of affective communication. However, it is very expensive and not universally available. Therefore, McLuhan would predict it would promote diversity in organization – centralization where it is available and decentralization where it is not.

INFORMATION AND COMMUNICATION IN A COMPLEX SOCIETAL CONTEXT

McLuhan is not the only author to have described the impact of communication on organization. There is strong support from military commentators for an idea that the cohesive strength of any aggregate of individuals depends on affective communication. The details at appendix 1 indicate in general that the more "personal" communication is, the better.

Cohesion, and group behavior, apparently depend not only on the type of communication but also on the organizational communications architecture – the topological arrangement of interconnection. However, it is difficult to describe the resulting modes of affective communication because of our general lack of appropriate metaphors for such interaction.[15] Healthy army units exhibit a network topology. They have formal structure and a "purpose" which is defined by a higher command authority. However, if they "disintegrate" in battle, their interconnections become more crowd-like.

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Networks promote solidarity and organization whereas crowds promote wave-like behavior.

The form of interconnection is also part of the way in which military units are described as self organizing complex adaptive systems."[16] They continually adapt to their environment as long as there is a catalyst present to enable evolution. In these models of military complexity, contextual information is that catalyst. Appendix 1 presents the views of several commentators supporting this idea.

Appendix 1 also provides detail about the contextual information model of Magoroh Maruyama and relates this to complexity theory. Maruyama emphasizes that information should be examined in the context of other related information so that differences in perception will be apparent.[17] These differences describe relationships that are not apparent from the isolated perception of the individual "pieces" of information.

The information theories above should serve to clarify the different perspectives one might have in thinking about "information." In reviewing these theories, one may observe the consistent notion that information exists and operates in the physical domain but has an effect (plays a role) in the cybernetic and moral domains.

The "meaningless" model is syntactic, not pragmatic. It quantifies the ordering of things, but it does not describe them – it is not "about" them. The commodity model provides good insight about what information *is* in a pragmatic and perhaps semantic sense. However, it does not fully address the *role* of information. The contextual social model provides this pragmatic functional aspect, but it does not relate these ideas to the other more familiar ideas about military operations. J.F.C. Fuller's *The Foundations of the Science of War* can help develop that relationship.

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BUILDING A COHERENT CONTEXT FOR THINKING ABOUT INFORMATION

The method used by J.F.C. Fuller in *The Foundations of The Science of War* enables the development of principles. These are unifying thoughts – not about what to *do* but rather about what to *consider* in the conduct of military operations. As a set of ideas, the principles are metaphors for the fundamental concepts upon which they are based. Fuller's work itself is based on a metaphorical extension of the nature of man. The notion of economy of force guides the actions of military units: Organizations control the exertion of – and resistance to – force or pressure in the physical, mental (cybernetic), and moral spheres (domains):[18]

Economy of Force			
	Resist Pressure	**Control**	**Exert Pressure**
Physical Sphere	Security	Mobility	Offensive Action
Mental Sphere	Distribute	Direct	Concentrate
Moral Sphere	Endurance	Determination	Surprise

Fuller's principles are similar to those found in US Army doctrine today. They are also the basis of the core functions described in emerging doctrine. However, they still do not provide a good model with which to unify the important aspects of the different information models. The development of that kind of coherent system of thought requires a revision of the doctrinal model of the cognitive hierarchy and an expansion of Fuller's ideas.

PRELIMINARY HYPOTHESIS

> *The rules of the game: ... when two texts, or two assertions, or perhaps two ideas, are in contradiction, be ready to reconcile them rather than cancel one by the other; regard them as two different faces, or two different stages, of the same reality, a reality convincingly human just because it's complex.[19]*

> Marguerite Yourcenar, *Memories of Hadrian*

UNDERSTANDING THE CORRESPONDENCE BETWEEN INFORMATION THEORIES

There is no elephant.

The various metaphors for information apply under different conditions and in different ways. However, it is possible to improve the contemporary view of the cognitive hierarchy. It is also possible to use the method of J.F.C. Fuller to establish a foundation for understanding the role of information in the military environment. Further, it is possible to combine these two revised models to demonstrate the correspondence between the various metaphors, and it is possible to illustrate the relationship between the nature and role of information and communication and the more familiar aspects of military operations.

RETHINKING COGNITION ACROSS THE MORAL AND CYBERNETIC DOMAINS

The goal of this section is to revisit the studies of information and communication theory and cognition and fix the superficiality of the contemporary model of the cognitive hierarchy presented in appendix 1. The end product is a revision of the related diagram.

The cognitive hierarchy should be studied in its practical context. The extremes of this context are the physical reality of the military environment on one hand and the mental and moral representation of that reality in the minds of military actors on the other. Note that all military actors are military decision-makers at some level of organization. Decisions lead to action. If individuals communicate effectively, then individual decisions tend to produce collective action that exhibits *coherence*. When the communication is primarily affective and decision-making is primarily values-based, the result is moral *cohesion*. No military actor acts in complete isolation – each is in a continual state of interaction with the military environment and the other actors in it.

The doctrinal model illustrated in *Joint Pub 6-0* and *FM 100-5* does not *fully* accommodate this practical context. **First**, the model does not adequately address the

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non-rational elements that influence understanding (or mis-understanding). *FM 100-5* does describe the hierarchy as a system that deals with uncertainty at each of the four levels, but it implies that the process is completely rational.[20] This is false, as is explained below. **Second**, the model does not adequately address moral influences on the system. **Third**, the model implies that "data" can be extracted from the environment and that it has "meaning" which can be discovered after processing. Both publications *do* indicate that relevant situational awareness is contextual.[21] However, neither supports its assertions with substantial argument. Thus the manuals' statements are "out of context" and lack meaning. **Fourth**, the model ignores the "social" or "collective" aspects of organizational use of information.

The model accommodates only information that is extracted from foreign objects in the environment and presented to a commander for cognition and judgement leading to action. Neither publication really accommodates the use of information that *originates* in one's own organization. For example, no commander's understanding, or the decision it enables, leads *directly* to action. Understanding leads directly to no action other than that taken by the *individual* who understands. A commander must articulate the decision to subordinates as missions/orders. The subordinates receive the missions/orders as data. They must process that data and then turn the resulting information into knowledge. Then they can understand their orders. Only then can they connect the data to any action that will cohere with that of peer-level organizations and the superior's intent. This may seem obvious when stated, but the model does not accommodate it.

The following paragraphs seek to provide the detail and rigor necessary to make this model complete and accurate. They concentrate on the areas of deficiency noted above.

The *environment* is physically real. It is both the place where the subject military actor *is* and the other actors and objects with which it interacts. The actor experiences the environment through interaction. Sensation provides direct experience and receives communication that provides vicarious experience of the environment. (The distinction between communication and sensation is clarified in the generalized communication model in appendix 1). The products of communication and sensation are "informative" and "affective" raw information – or "*data*."[22] In Hayakawa's vocabulary, data consists of the symbols and presymbols used by the sensory and communication systems to *represent* reality.

Data is then *processed*.[23] Like in Spencer's universal law (presented in appendix 1), there are two basic categories of processing: *aggregation* and *disaggregation*. A typical aggregation is the collection of a sequence of signs and the recognition that they form a symbol. For example in verbal communication, a sequence of sounds (signs) forms a word (symbol). A more complex aggregation is the military intelligence function of data "fusion" which goes beyond simple collection. For example, analysts might collect information from several different sources on the same target. Fusion is the correlation of that information with other intelligence and the assembly of a revised representation of the target.

A typical disaggregation process is the identification of one available signal as the carrier of relevant information and others as noise – and the subsequent action to

eliminate the noise or enhance the signal relative to it. This is also called "filtering." A more complex disaggregation is the "filtering" performed by a staff preparing a briefing for its commander. Another example of disaggregation is the dissemination of information supporting the execution of an order.

Examples of Aggregation	Examples of Disaggregation
1. Collection	1. Filtering
2. Fusion	2. Dissemination

Aggregation reduces uncertainty by improving the completeness of the problem sector, but it takes time to accomplish and it requires information storage and transmission resources to maintain. Disaggregation increases efficiency in decision-cycling by improving brevity and narrowing the problem sector, but it tends to reduce the flexibility and adaptability of the resulting set of knowledge. The reduced set of knowledge can fail to accommodate the changing needs of the problem solvers. Therefore, brevity *contends* with completeness. *Aggregation contends with disaggregation. Neither extreme is absolutely appropriate in any circumstance. The desire is a set of knowledge that supports the information requirements of problem solving – a set that is robust enough to provide operational freedom of action but not so cumbersome as to impede operational tempo.*

The result of all this processing of data is doctrinally referred to as (processed) *information*.[24] Some processed information is "informative." It informs the faculty of *reason*. Reason uses this "informative" information much like the description of processing above. Rules of logic and inference are applied and justifiable belief (knowledge) is the result. Some of the processed information is "affective." It influences the moral or emotional state and thus the faculty of *intuition*. The faculty of intuition

does what reason cannot. It draws non-rational conclusions (still justified beliefs) to fill "information gaps" and enable the production of beliefs through *cognition*.[25] These beliefs are often justified by their coherence with other beliefs, hopefully based on empirical evidence or experience. Other beliefs are justified by their emotional appeal or by conjunction with other strongly held beliefs. Note that these methods of justification are not completely rational. Therefore, this faculty is a double-edged sword just as is metaphorical communication. It is subject to the same "sins of cognitive illusion" that are facilitated by metaphor.[26] The process of cognition (the combination of reason and intuition) produces justifiable beliefs that are usually also consistent with other beliefs.[27] Without absolute proof, this is as close as one can get to "absolute" *knowledge*.[28]

A body of knowledge is then a collective set of cognitively justified beliefs. The actor assesses the relevance of these beliefs, perceives and distinguishes relationships between elements of knowledge, and draws more conclusions by comprehension and analysis.

The actor simultaneously *evaluates* those conclusions as well as the knowledge and information they are based on – assessing them dynamically against a *value* system. The result of this *affective* e-*valu*-ation is a modification of the way affective information and knowledge are handled by intuition. This "recursive" interaction of cognitive and affective processes is *judgement*.[29] Its dynamic product is *understanding*.[30] Like cognition, judgement is not purely rational. It connects the cognitive and affective domains at several levels. As understanding improves, so does the "precision" of the evaluation and the affective *commitment* to the judgement. This is the source of determination and non-rational "certainty."

This revised cognitive-affective hierarchy is depicted below. Note that it shows what the doctrinal cognitive hierarchy does not:
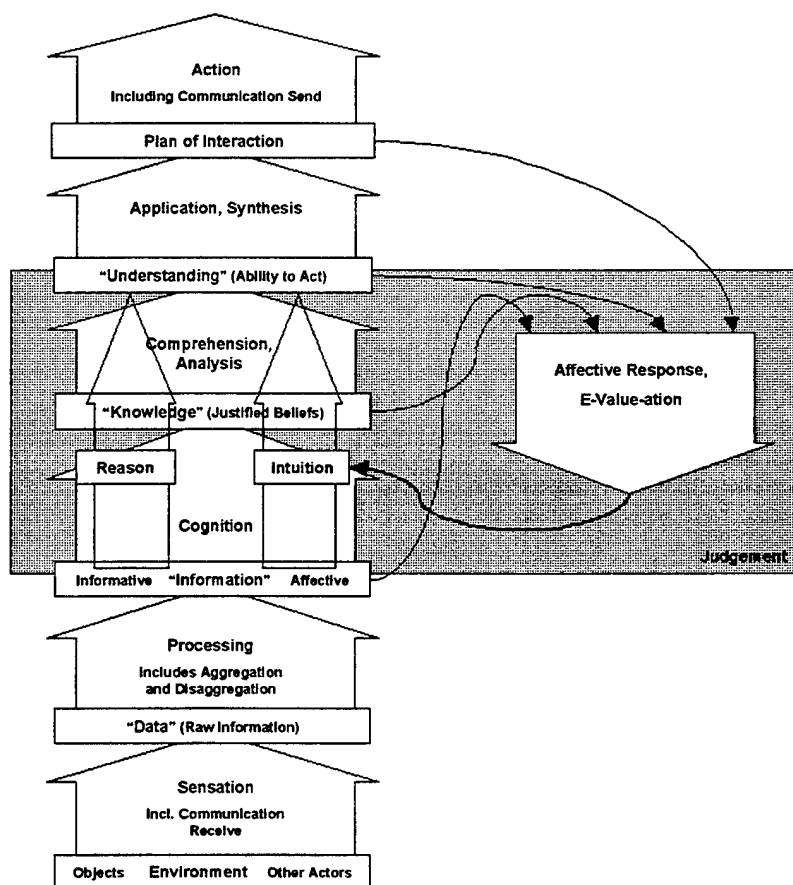
Every member of the military may be described as a "purposive actor" – a decision-maker who is continuously "coping" with the present by planning to *shape* the future. This usually means choosing a course of action or problem solution based on a cognitive-affective consideration of potential courses of action and associated likely outcomes. Instinctive and reflexive responses are exceptions to the deliberate choice model, and they deserve a small space for consideration. Note that true instinct is not something learned, but rather genetically coded before birth. Conditioned reflexes, on the other hand, *are* learned. They may be viewed in the current model as the extreme of brevity in the cognitive process. All reasoning and judgement regarding the appropriate

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action in a given circumstance has been performed *a priori*, and a high moral value has been associated with immediate action in these circumstances. All that remains is recognition (re-*cognition*) of the circumstance. It may also be possible to view military battle drills and even contingency plans as the collective extension of this kind of action. However, such an aggregate view of "collective action" obscures the necessary information exchanges that must occur within the organization. Such exchanges happen in order to (1) sense and recognize the circumstance, (2) communicate this to the members of the organization (notification), (3) direct the initiation of the action (optional if prior training includes equation of notification with direction to execute), (4) coordinate and control the action, and (5) report the action higher/laterally. The importance of affective forms of communication in these circumstances is *entirely* missing in such an aggregate view of collective action as a "reflex." This is addressed by several military commentators like S.L.A. Marshall, and it is discussed in more detail in appendix 1.

In the individual view, the purposive actor is both problem solver and decision-maker. This actor desires the best possible "understanding" of the situation (the nature of one's "state" relative to the environment and the other actors in it). "Good understanding" is desirable because the actor will choose available "solutions" or "courses of action" most *likely* to achieve the actor's purpose. Perfect understanding and perfect likelihood (certainty) of success is not possible. The individual can only experience interaction with a small fraction of the other "things" and individuals in the environment. Further, the individual does not actually retain the experience – but only the subjective representation

of it in his mind – quantitatively and qualitatively at different cognitive levels. So all problem solving and decision-making occurs under uncertainty.

Even once the decision is made and a solution is chosen, action must be initiated. If the decision is an individual's choice to shoot at a target, this is relatively simple – no other individuals are involved. However, if the decision is a commander's choice to adopt a branch to a basic course of action, then the commander must communicate this as an order, control its execution, and notify higher and lateral commanders. Actually, this expression of the required action (though it is consistent with almost all US Army Field Manuals today) is as much an inappropriately aggregate collective action as the example above. In reality, the commander does not solve problems and decide alone. Hopefully, there is a staff that facilitates this process.

The staff *tends* to operate on the informative side of the cognitive-affective model. For example, it disseminates the commander's intent and concept of operations in orders, and it collects and processes status reports. Normally, each of these kinds of exchanges of information are conducted using a system designed for brevity, like verbal brevity codes or computer data transfers. Even written orders use a doctrinal subset of the language – a reduced vocabulary of doctrinal terms.

The commander, on the other hand, *tends* to operate on the affective side of the cognitive-affective model. Commanders go wherever they can best communicate with whomever it is most important that they communicate in order to ensure that their intent is accomplished. This communication will be informative, but it will also be far more affective than the communication accomplished by the staff. The US Army leadership doctrine that the commander provides *purpose*, direction, and *motivation* seems to

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recognize the importance of affective communication. Almost every military critic says that face-to-face communication, like leading from the front, is the best way to do this. The more "personal" the communication, the more affective.

This revised way of seeing a cognitive-affective hierarchy instead of just a cognitive one reconciles the art-science, intuition-logic, passion-reason dichotomy. However it does not explain the relationship of this view of information and communication to other more familiar aspects of military operations. This is addressed in the next section.

RETHINKING THE NATURE AND ROLES OF INFORMATION WITH FULLER'S METHOD

Largely due to Fuller's influence, recent US Army doctrinal development has emphasized the use of "core functions" as doctrinal terms. *FM 100-5 (Final Draft 1997)* quotes Fuller's *Tactics and Mechanization* (1927):

> We must cease to think in names (Cavalry, Artillery, Infantry) and must learn to think in the terms of tactical functions... Weapons change in form, and their names change accordingly; but functions remain constant in nature... If we will persist in thinking out tactical problems in terms of Cavalry, Artillery, and Infantry, then we shall render our minds rigid to all new ideas. To persuade our minds to become flexible and recipient we must think in functions.

FM 100-5 (Final Draft 1997) continues:

> In conducting operations, Army forces perform five core functions: **See, Shape, Shield, Strike, Move**... Core functions are the fundamental actions forces take to apply military power. They should not be viewed independently of one another but as inseparable parts of a whole. Indeed, these core functions have no utility except in relationship to one another and the objective being sought. *The core functions apply to all operating systems, categories of operations, and levels of command.*[31]

Given that Fuller wrote *Tactics and Mechanization* after *The Foundations of the Science of War*, one might expect to find some influence of the earlier thinking in the later work. The table below contains the principles of war Fuller articulated in *The Foundations of the Science of War*, but here the names are reinterpreted as **"functional" verbs**.

Core Functions			
	Resist Pressure	*Shape*	*Exert Pressure*
Physical Domain	Shield	Move	Strike
Cybernetic Domain	Disperse	Decide and C2	Concentrate
Moral Domain	Endure	Determine and Lead	Surprise

Here, shaded, are four of the five core functions in the *FM*. Note that this revision is missing the function *See* and also that it has six additional functions that do not appear in the *FM*. Incidentally, the emerging *FM 100-5 (Revised Final Draft, 1998)* currently renames *see* as *sense*, and it adds *control* and *sustain* to the list of core functions.[32] Actually, Fuller's text calls the relationship between resistance and exertion of pressure "control," but it is called *shape* here because that is the name doctrine applies to the core function that describes the intelligent "control" over the interaction with the adversary. Fuller's "control" is multi-dimensional. It describes physical, cybernetic, and moral effects in the same way that the doctrinal term *shape* does. Anyone who has the ability to *shape* – anyone who has that kind of multi-dimensional "control" – has *freedom of action* and can exercise the *initiative*. Doctrine on the other hand uses the term *control* as a cybernetic function. *Control* systems operate as physical extensions of military organizations, but they achieve cybernetic effects.

This doctrine is based on the belief that military conflict becomes decisive when the adversary no longer has the *will to resist* and *decides* to stop. In battle, this occurs as the adversary undergoes cybernetic disorganization and ultimately moral disintegration – when it loses its *cohesion*. However, *will to resist* is a moral thing and is virtually impossible to influence directly. Some cybernetic systems are vulnerable to attack, but they are attacked as physical targets. For example, in deception, the cybernetic errors resulting from false beliefs derive from the physical information that presents the

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deception story. Military actions are chosen for their *effects* in the moral and cybernetic domains, but the military actions themselves occurs in the physical domain. This is as true for communication as it is for destruction. Information is a physical ordering of some physical thing to represent the ordering of some other thing. Communication is the transmission of that representation by the temporal ordering of some spatially extended medium to represent the ordering of the information. When communication is sufficiently informative, it has operated in the physical domain to generate effects in the cybernetic domain. When it is sufficiently affective, it has operated in the physical domain to generate effects in the moral domain.

Note that the *FM* does not consider planning (problem solving) or decision (solution choosing) to be core functions. The emerging doctrinal model represents these processes as cybernetic subsets of *control*. However, the very inclusion of *control* as a core function demonstrates the emerging doctrinal belief in the collective function of the organization in the cybernetic domain. *Control* is an organizational function. It is executed through individual physical activity involving physical information. However, its collective effect is manifest in the cybernetic domain. There are organizational moral functions as well. Note that the notion of *shaping* involves problem solving: figuring out how to *shape* the interaction with others and the environment in the right way at the right time. Every commander, and every unit, however time-constrained, *always* plans, and *always* decides how this interaction should be *shaped* – even if the decision is not to decide right away.

There are a core functions here in need of names. *Shaping* involves functions in each of the domains – physical, cybernetic, and moral. The core cybernetic function that

shapes is more than just "control". There is no single doctrinal or theoretical term for it, but it involves both the aggregate process of *decision* and the aggregate process of *command and control*. *Decision* includes planning and the authoritative direction to execute a plan. *Command and Control* are the cybernetic means of execution. Martin Van Creveld proposes an easy fix: "I will use the word 'command' throughout much the same way as people commonly use the term 'management' to describe the manifold activities that go into the running of a business organization."[33] Van Creveld's manifold of command is a responsibility, a function, and a process; however, he also recognizes that as a process, it is not entirely rational and that it resides in the moral as well as the cybernetic domain.[34] So the core cybernetic function that *shapes* is more than "control" but less than Van Creveld's aggregate "command," and it is still in need of a name. For now, this monograph will name this function by concatenation of the requirements identified: *Decide and C2*.

The core moral function that *shapes* is more than "morale." Morale results from determination, and soldiers get determination from the affective communication they experience with their peers and their leaders. Thus the leader who wishes to *shape* the moral domain must execute the moral analog of decision – determination – and effect this by leadership. Therefore, this monograph will call this function by the concatenation of these requirements: *Determine and lead.*

In the table above, the functions shown in the row of the cybernetic domain are the rational aspects of the planned action (the task organization of forces and their distribution on the battlefield) and its coordinated and controlled execution. The functions shown in the row of the "moral domain" are the non-rational emotive aspects of

the decision (determination) and desirability of friendly forces to endure hardship and to surprise the enemy. These functions are as important and as fundamental as *Shield*, *Move*, and *Strike*.

However, it is important to notice that *Sense* is still missing because it is obviously a basic requirement for dealing with information. It is missing because the basic mental model from which Fuller derived these functions is the metaphorical "individual human warrior." Indeed, the human body is one of Fuller's archetypes. This metaphor leads to the aggregation of several functions in each domain in a counter-intuitive way. It also fails to convey the distributed, complex, self-organizing, adaptive nature of the "instrument of military action." The individual is not the appropriate archetype – the organization (or maybe the "organism") is. Recall, information and communication are the catalysts of organizational evolution.

Marshall McLuhan says that the structures of organizations and the nature of their activities are defined by the communications media they employ. Taking his comment, "The medium is the message" as a founding principle or alternative paradigm, it is possible to construct a revised set of core functions. *Interactive relationships with others and the environment can be described as "communication" with others and the environment.* It is the use of the available media of communication that defines how these relationships are *shaped*. In this model, every form of interaction with an adversary, a friend, a neutral, or even the terrain, is a medium of communication. Note that the media of interaction with adversaries, forms of military interaction, *contain* the medium of "economy of force" – Fuller's basis for principles and core functions. The

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table below is revised to reflect this mode of thought, core functions of the emerging *FM 100-5 1998 (Revised Final Draft)* are shaded:

Core Functions – Interaction as Communication			
	Receive	*Shape*	*Transmit*
Physical Domain	Shield	Transition (replaces move)	Strike
Cybernetic Domain	Sense and Aggregate	Decide, Command & Control	Disaggregate and Send
Moral Domain	Endure	Determine and Lead	Surprise

Naturally, any simple table like this will be somewhat reductionist. However, whereas the previous chart hid the *sense* function, this one hides the physical actions *concentrate* and *disperse*. However, the functions *aggregate* and *disaggregate* are analogous. These are the labels for *collect* and *disseminate* when it comes to information. Note that if these functions are applied to all forms of cybernetic commerce and support, including logistics, instead of just information, then they account for the function *sustain*. Also, In this table, the label *move* has been replaced by the function *transition* because it better describes the universality of the idea that the physical nature and activity of an organization changes as it *transitions* from state, stage, or phase to another. This idea is also emerging in the collective military vocabulary. In fact, the Battle Command Training Program seminar curriculum includes an entire two hour seminar on *transitions.*

It is important to understand that *all* forms of interaction are media that contain other media as a message. It is also important to understand that this model is not limited to interaction with enemies. It is equally applicable to interaction between individuals or between friendly or neutral nations or military organizations. For instance, simple command and control computer communication from a Joint Task Force (JTF) to its

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parent Joint headquarters may contain (represent) disposition and activity, and disposition and activity, in turn, may represent physical shaping, and so on.

Another, higher level, example demonstrates the universality of this model. The four "instruments of national power" (Diplomacy, Military Activity, Information, and Economics) are actually media for communicating with other national or meta-national groups. Consider nation A interacting with nations B, C, and Non-Governmental Organization D. From nation A's perspective, it has chosen a blend of the instruments of power to signal its intent to protect its interests. This collective blend of media is the extension of nation A in interaction with others. It is the extension of the *policy* of nation A – it contains (represents) the policy of nation A as a message. From Nation C's perspective, this message is received as the pattern of behavior of nation A, in all media. To nation C, the policy of nation A is defined not by nation A's intent, but by its communication in all forms – by its behavior. Failure to communicate effectively could well lead to the use of only the military medium. Thus the dichotomy – the otherwise apparent contradiction between perspectives – vanishes: War is the extension of policy (what one communicates is determined by the receiver, not the sender) *and* war is the bankruptcy of policy (failure to communicate effectively is determined by the sender).
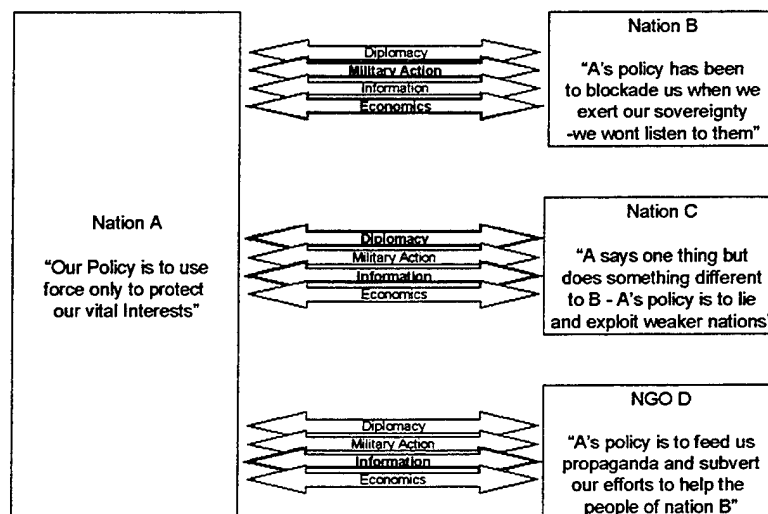
A revised diagram showing the correspondence between the cognitive hierarchy and the principle functions is shown below. Note that *shape* is performed by collectively planning and then acting out a set or a sequence of core functions which are spatially and temporally coordinated (distributed and synchronized or orchestrated) such that actions of some actors set the conditions for successful action by other actors.
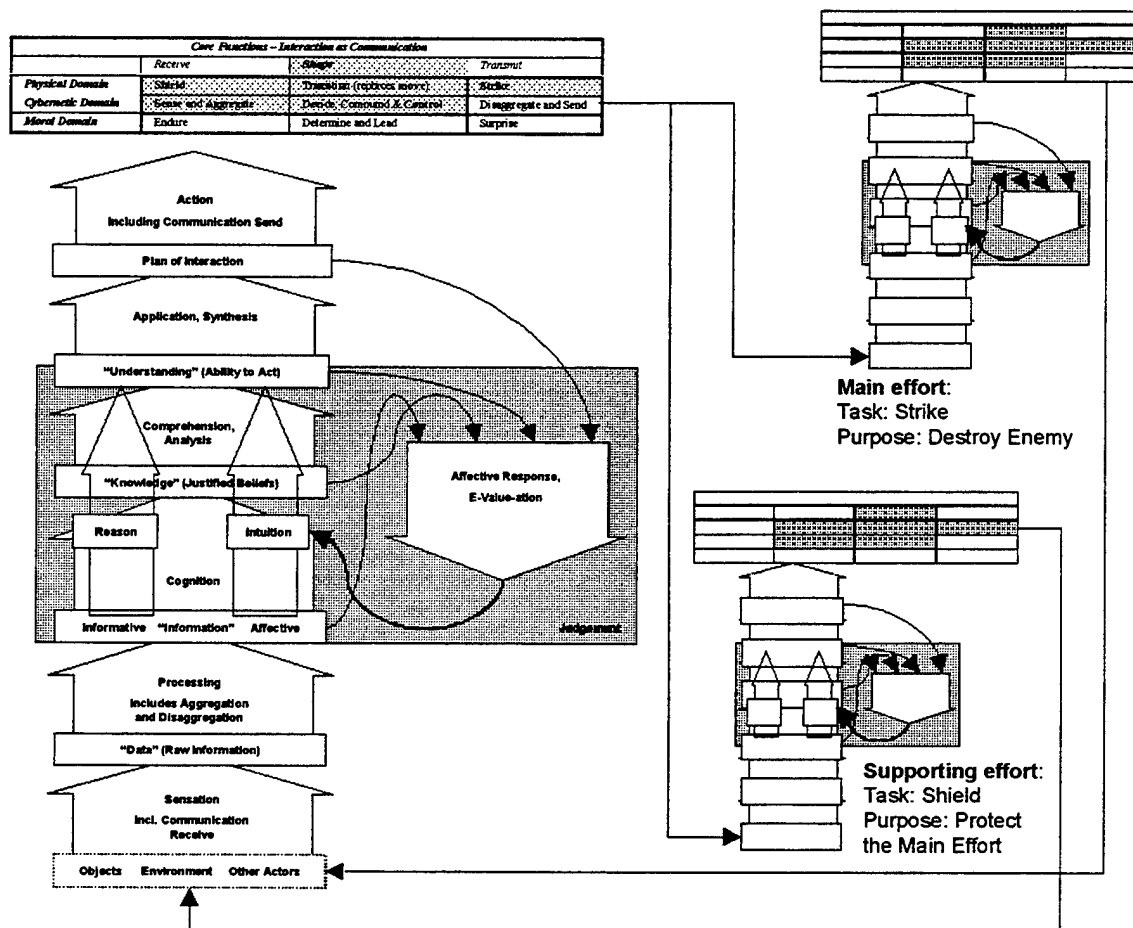
DATA, METHOD, AND ANALYSIS

DATA AND METHOD

This section describes the use of metaphors in military doctrine to explain the nature and role of information. It references other uses of those metaphors in military

writing, explains the mental models used and their limits of applicability, and it evaluates the fidelity and general utility of these metaphors.

ANALYSIS OF THE MILITARY ROLES OF "INFORMATION"

Information is not just a cybernetic commodity, and military communications support much more than just military problem solving. While these are indeed roles of information, there are other important roles as well. They are not as easy to understand, though. The following section identifies and develops the roles of information in the military environment. This development begins from *what* information *is* in the physical domain – a representation of some ordered "thing." The result is an expansion of the understanding that while information *exists* and operates in the *physical* domain, the tangible *effects* of its *use* are manifest in the *cybernetic* and *moral* domains. Therefore, one can say that information plays its *roles* in the cybernetic and moral domains.

There are three principle things that information represents for members of military organizations. The first is the *current reality*. Information represents the current physical situation, including current trends and changes in the environment and the other individuals and organizations in it. The second is the *desired reality*. Information represents the organization's *vision* of the way it would the environment and the others in it to be. The third is the *plan*. Information represents the *vision* for how to make the transition from the current reality to the desired reality – how to shape the environment and the others in it. The Military Decision-Making Process produces the plan, but the plan is implemented by subordinates who receive it as information. Often things do not go as planned, and subordinates are called upon to exercise initiative. The paragraphs

below describe how military organizations use information to cope with the dynamic complexity of their environment.

CLASSIFYING THE ROLES OF INFORMATION IN MILITARY ORGANIZATIONS

Military organizations are designed to facilitate the continual transition from the ***current reality*** toward the ***desired reality***. In the simplistic view, military structure is hierarchical organization of leader and led – a ***commander*** and the commander's followers. A more complex view includes the ***staff*** – an organization within the organization that "exist[s] to help the commander make and implement decisions... Staff organizations and procedures are structured to meet the commander's critical information requirements."[35] A yet more complex view acknowledges that most military organizations consist of several ***subordinate organizations***. These subordinate organizations perform a mixture of general purpose and specialized functions. The collective behavior of the parent organization is defined by the actions taken by its components according to their shared vision. Both the actions these components take and the vision they share are determined by the way these components share information with each other and their parent and subordinate organizations. Further, an even more complex view acknowledges that military organizations interact with one another *and* their adversaries *and* many non-military groups such as civilians, refugees, and Non-Governmental Organizations like the International Red Cross. In this view, the current state of these interactions defines reality and the desired state of these interactions defines the desired reality.

Regarding interaction between components of friendly military organizations only, there are two general classes of standard activities by which units continually

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transition from the current reality toward the desired reality First, there is a class of standard activities which together make up the doctrinal Military Decision Making Process (**MDMP**). Though this process may range from deliberate to highly abbreviated, it always produces at least the commander's intent. The intent includes at least the commander's articulation of the purpose and desired end-state of the upcoming action. This is the minimum *plan*. The MDMP involves the collection of information to support the development of problem-solutions and to support the decision. The second class of such activity is **control** of the execution of the action. At least initially, this is according to the plan, but as the situation changes, so does the appropriate action. Both of these classes of activity require communication. This communication and the information it provides acts in the moral and cybernetic domains to make the organization *cohesive* and to make its collective actions *coherent*.

US military doctrine tends to describe these activities – the interactions of commander, staff, and subordinates – as if "the commander" is the only intelligent creature in any given organization. This stems logically from the fact that a commander is the single individual who exercises lawful *authority* "over subordinates by virtue of rank and assignment."[36] Only the commander issues authoritative orders. However, this language tends to obscure the fact that the organization is still a collective of many individuals. Actually, *FM 100-5 (Final Draft, 1997)* counteracts this trend by including *teamwork* as a command imperative: "Every commander is also part of a team – his command."[37] Most current doctrine, however, fails to articulate that message – and that individuals act according to their own personal visions.[38] *A commander's vision is meaningless unless it is shared.* Further, commanders' visions do not simply

spontaneously generate themselves in commanders' minds. ***Commanders' visions are the judgmental result of the interaction between commanders, their staff, their subordinates, their adversaries, their environment, and other actors in their environment.*** A commander's vision is much more than the commander's "visualization of the battlefield," though the latter is required to develop the prior. Staff members, subordinates, peer-level commanders, and superiors all communicate with the commander to help the commander understand the ***current reality*** and decide on an appropriate solution to the problem of "What is the ***desired reality***, and how do we get there from here?"[39] Thus, the commander's vision is actually a collective product. Likewise, the military organization is actually a ***gestalt*** – albeit structured – entity.[40] The commander is the critical node in this complex view of military organization. As such, one function that falls uniquely to the commander is control of the scope of the vision and the tempo of the process by which it is developed, captured, and shared with others.

In the first class of activity (MDMP), the commander communicates vision via an intent paragraph in a plan or order. At the lower levels, there may only be enough time in the MDMP to articulate just that intent and as a result, it *is* the plan – or at least it is a "*snapshot*" of the plan and the vision. Military operations are continuous, but they are accomplished by discrete actions over discrete bits of space and time. The rate at which these actions occur is "tempo." The doctrinal tenet of synchronization and the emerging notion of orchestration recognize this. The rhythm of the decision-making process is one of the things that must be synchronized with other activities. This process, in turn, will determine the nature and the criticality of information requirements.

In the second class of activity (execution), all parties in the organization monitor and attempt to *shape* and adapt to the dynamic situation. The means by which they accomplish this are Command and Control (C2) and Leadership & Management (L&M). Again, most doctrinal language describes these simplistically, and again this obscures the fact that C2 and L&M are *organizational* processes – and therefore inherently collective. Each of these has an impact on information requirements.

Action also implies interaction with others, and interaction implies communication. This is especially pertinent at the military operational level – where interaction with other groups in the environment crosses the boundary from diplomacy to military activity. Organizational process models gauge the effectiveness of such a communication system by the degree of "coupling" it develops between communicants. Joseph F. Bouchard makes such an argument in *Command in Crisis: Four Case Studies*.[41] Bouchard's organizational process model explains that tightly coupled systems of potential adversaries are more likely to be able to resolve successfully a crisis than loosely coupled ones. Extending this argument, tightly coupled systems make good use of information and make achievement of the military objective less costly.

"Coupling" might be a good way to think about the role of information and communication. "Coupling" with one's own component organizations, or even with the individuals in one's organization, is a good description of moral cohesion and its effect, coherence. "Coupling" with the enemy determines what the enemy "knows." This is one of the central ideas behind the currently vogue notion of "information dominance." However, this "coupling" is also a useful way to look at interaction with non-military groups such as civilians, refugees, and Non-Governmental Organizations like the

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International Red Cross. US joint doctrine recognizes these requirements, but it has a

different name for each. Communicating to the enemy is called "psychological

operations" (PSYOPS) in the moral domain, or "deception" in the cybernetic domain.

Preventing the enemy from effective internal coupling is called "Command and Control

Attack" (C2 Attack). Doing this by electronic means is called "Electronic Warfare"

(EW). Protecting one's own internal coupling is called "Command and Control Protect"

(C2 Protect) and "Operational Security" (OPSEC). OPSEC, PSYOPS, Deception, EW,

and Physical destruction are collectively referred to as "Command and Control Warfare."

Communicating with the civilian population of one's own country is called "Public

Affairs" (PA). Communicating with other non-military actors or other civilians in the

theater of operations is called "Civil Military Operations" (CMO) or "Civil Affairs"

(CA).[42]

Whether it is the right thing to do or not, emerging doctrine places all these

activities under the supervisory responsibility of an Information Operations Cell.[43]

Martin C. Libicki addresses this issue in *What is Information Warfare*. He identifies

seven forms of information war:

> ***Information warfare as a separate technique of waging war, does not exist.*** There are,
> instead, several distinct forms of information warfare, each laying claim to the larger
> concept. Seven forms of information warfare – conflicts that involve the protection,
> manipulation, degradation, and denial of information – can be distinguished: (*i*)
> command and control warfare (which strikes against the enemy's head and neck), (*ii*)
> intelligence-based warfare (which consists of the design, protection, and denial of
> systems that seek sufficient knowledge to dominate the battlespace), (*iii*) electronic
> warfare (radio-electronic or cryptographic techniques), (*iv*) psychological warfare (in
> which information is used to change the minds of friends, neutrals, and foes), (*v*)
> "hacker" warfare (in which computer systems are attacked), (*vi*) economic information
> warfare (blocking information or channeling it to pursue economic dominance), and (*vii*)
> cyberwarfare (a grab bag of futuristic scenarios). ***All these forms are weakly related.***
> ***The concept of information warfare has as much coherence as the concept, for***
> ***instance, of an information worker.***[44]

Note that Libicki's idea is consistent with the joint doctrine, but the conceptual boundaries differ. What doctrine distinguishes as PA, CA and PSYOPS (for significant legal reasons), for example, Libicki lumps together as psychological warfare. What doctrine lumps together as C2W, Libicki distinguishes as C2W, intelligence-based warfare, and electronic warfare. There are conceptual differences here because Libicki uses the term "warfare" only metaphorically – these are types of conflict between adversarial groups that may or may not align with national or military organizations. However, Libicki's claim that the various functions are only weekly related is valid.

Even if C2W is viewed as a unified set which includes "hacker" and "cyber" warfare, and even if we disregard the legal aspects separating PA, CA, and PSYOPS, and consider them to be "psychological" warfare, the two remaining sets are significantly different. C2W and psychological warfare approach the use of information from completely different perspectives – not even focused in the same domain. C2W is focused on the cybernetic domain, though its application may include psychological techniques like deception and its results may have moral effects on military organizations. Psychological warfare is focused on the moral domain, though its application may include cybernetic-like techniques such as lobbying a legislative decision-making process, and its results may have cybernetic effects on military organizations.

So, it does not appear logical that all the related functions should be placed under a single IO cell. There are two possible explanations why this is happening anyway. First, since the increased relevance of information, due in part to the increased reliance on information systems, is a relatively new phenomenon, soldiers do not completely

understand what information is or the concepts regarding its use. This makes it logical to put responsibility for it in the hands of those few that *do* understand it. On the other hand, this will reinforce the ignorance of those who do not. They will not be forced to learn these concepts, and the concepts will not truly become part of the shared understanding of military operations. Second, there has to be *some* point where someone ensures that efforts of the different Battlefield Operating Systems are mutually supportive. A "targeting cell" does this where air- and fire- superiority are concerned. So naturally, some say, an information cell should do it for information-superiority. However, this is the result of flawed metaphorical thinking. The real result it has is to divorce principal actors from their responsibilities regarding the use of information and communication. This is counter to the organizational principles described above.

The section above documents two basic classes of military organizational processes involving the communication of information, two classes of the results of that communication, and it classifies all military action as *inter*-action. *Command and Control (C2)* and *Leadership and Management (L&M)* are both involved in the MDMP and the execution of military interaction. Both are involved in the development and use of the gestalt-command's vision – a collective product. The results of C2 and L&M in the moral and cybernetic domains are *cohesion* and *coherence*. These characterize one side of military action – they provide only a subjective view. The models of McLuhan and Bouchard provide an objective view of military interaction – in which military action is but one of several media for communicating policy.

The next sections examine the role of information and communication in the areas of Command and Control , Leadership and Management, and moral cohesion and cybernetic coherence in more detail.

INFORMATION AND COMMUNICATION IN COMMAND AND CONTROL

Classical theoretical models of command and control and decision making are detailed at Appendix 2.

Effective Command and Control requires both informative and affective communication. *Joint Pub 3-0, Doctrine for Joint Operations*, and US Army *FM 101-5, Staff organization and Operations* both describe C2 in a manner consistent with the discussion above. Both note that authority centralizes the process on the commander. Both describe C2 as a classical cybernetic process involving feed-forward direction and feedback control. Thus, both doctrinal manuals state requirements for *informative* communication. The result of this cybernetic system is ***coherence*** in action. Subordinate action supports the commander's intent, and the overall effect of the collective action of the unit, *and* its peer level units, supports *their* parent unit commander's intent.

This informative communication is a feature that is promoted by the use of brevity codes and computer to computer transfers. Computers are not affected by such transfers and "SALUTE Report: engaging 5 BMPs and 3 T80s travelling south at HJ1234356, 120445Z" has an entirely different meaning when seen on a computer display than "THEY'RE ALL OVER US!" heard coming from the radio's speaker in the Tactical Operations Center (TOC). The first is highly informative but relatively speaking, it is not emotive. The second is highly emotive, but not very informative. The rationale for brevity is maximizing the efficiency of communication and subsequent

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decision making. In the cybernetic model, action is a result of decision in a rational

Military Decision Making Process (MDMP). It is desirable to act first, with initiative, to

shape the future and keep the enemy in a state of reaction. Therefore, the desire for

decision certainty contends with a requirement for decision rapidity.

Both doctrinal manuals also contain understated requirements for *affective*

communication – as a means for motivating soldiers and maintaining *cohesion*.[45] In the

framework of this monograph that is a *leadership* responsibility (belonging to the

commander), *not* a C2 responsibility. However, there *are* affective communication

requirements in C2 – they are just not mentioned in either of the doctrinal publications

because they are not part of the mental model upon which the doctrine is based. Military

decision-making is the central activity of the cybernetic process, and it requires *affective*

as well as *informative* communication between its participants. As described above,

central to military decision-making is the development of a shared vision. And *only*

through the effective combination of affective and informative communication (such as

occurs with the choice of good metaphor) is the development of shared vision possible.

The Command and General Staff School course C710, *Senior-Level Leadership*

and the Art of Command, separates "Command and Control" and "Leadership and

Management" as two sets of processes for achieving the senior-level commander's

vision.[46] This approach is applied in the following section.

INFORMATION AND COMMUNICATION IN LEADERSHIP AND MANAGEMENT

Effective Leadership and Management require both informative and affective

communication. Leadership is an embedded requirement in command. US Army *Field*

Manual 22-100: Military Leadership defines leadership as "the process of influencing

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others to accomplish the mission by providing purpose, direction, and motivation."[47] This same word-use appears in *Joint Pub 3-0: Doctrine for Joint Operations...* "Command at all levels is the art of motivating and directing people and organizations into action to accomplish missions."[48] Evidently, the distinction between command and leadership in doctrine is devolving, but in this monograph, it is useful to distinguish between the two sets of processes – command and control (C2) and Leadership and Management (L&M). As demonstrated below, L&M concepts are valuable for describing the process of building and maintaining cohesive organizations – a moral function. C2 concepts, by contrast, are more efficient at describing the process of keeping organizations on course, in coherent action – a "steering" or cybernetic function.

In "What Leaders Really Do," an essay in *Military Leadership: In Pursuit of Excellence*, John P. Kotter says:

> Leadership is different from management, but not for the reasons most people think. Leadership isn't mystical and mysterious. It has nothing to do with having "charisma" or other exotic personality traits. It is not the province of a chosen few. Nor is leadership necessarily better than management or a replacement for it... Rather, leadership and management are two distinctive and complementary systems of action.[49]

Kotter's essay originally appeared in *Harvard Business Review* and has a corporate perspective, but his views on Leadership and Management are applicable in the military environment as well. That is why the essay appears in *Military Leadership*. Kotter says, "Management is about coping with complexity... Leadership, by contrast, is about coping with change."[50] (Of course complexity can be dynamic, in which case the two are intertwined.) He explains that the two are *not* mutually exclusive in an individual, and that "Smart companies... groom their top people to provide both."[51]

In Kotter's model, organizational issues are handled using both processes.

> [Organizations] manage complexity by *planning* and *budgeting [resourcing]*... management develops its capacity to achieve its plan by *organizing* and *staffing*...

management ensures plan accomplishment by *controlling* and *problem-solving*. [On the other hand,] setting the direction of change is fundamental to leadership... Direction-setting doesn't produce plans [which are deductive in nature]; it creates *vision* [which is inductive in nature, and useless if not shared].[52]

Whereas management organizes, leadership "aligns" people with the vision. This is a process of sharing the vision that is a bigger communications requirement than organizing. "The target population can involve not only a [leader's] subordinates, but also bosses, peers, staff... as well as suppliers... or even customers."[53] Further, whereas management controls and problem-solves, leadership motivates:

Good leaders motivate people in a variety of ways, First, they always articulate the organization's vision in a manner that stresses the *values* of the audience... [also they foster] coaching, feedback, and role modeling... Finally, [they] recognize and reward success [which makes recipients] feel like they *belong*... When all this is done, the work itself becomes intrinsically motivating.[54]

There is obvious overlap between the processes of leadership and management. However, Bloom can help categorize the differences. Kotter's perspective implies that the process of management involves communication to use information in the *cognitive* domain, whereas leadership involves communication to use information in the *affective* domain. These are *informative* and *affective* uses of information, in Hayakawa's terms.

These appear initially to map directly to the cybernetic and moral domains respectively. However, there are *both* informative *and* affective requirements for information in *both* the cybernetic *and* moral domains. The need for intuition in cybernetic decision-making is an example on the one hand. The need for a "reason-to-believe" in moral (values-based) judgement is an example on the other hand.

The discussion above demonstrates the utility of the different perspectives associated with the concepts of C2 and L&M. L&M is better at describing the source of cohesion, and C2 is better at describing the source of coherence. These two ideas are examined more closely, below.

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Information and communication produce a sort of "binding" in the moral and

cybernetic domains. These effects are often refered to as "cohesion" and "coherence."

This section examines these phenomena and the role of information and communication

as their source.

In *Combat Motivation*, Anthony Kellett validates the World War II observation of

Field Marshall Montgomery:

> there is a difference between cohesion and esprit, as was not infrequently made evident in
> Vietnam. Cohesion denotes the feelings of belonging and solidarity that occur mostly at
> the primary group level and result from sustained interactions, both formal and informal,
> among group members on the basis of common experiences, and shared goals and
> values... Esprit denotes feelings of pride, unity of purpose, and adherence to an ideal
> represented by the unit, and it generally applies to larger units with more formal
> boundaries than those of the primary group.[55]

The seed of a unifying thought is here. The *effect* of what Montgomery and

Kellett have called Esprit is **coherence** – collective action toward a common goal. At the

primary group level, the effect is actual **cohesion** – moral bonding. The distinction may

be semantically subtle, but while cohesion does literally mean the act of cohering, both

terms also inherit meanings from classical physics which have come into popular use, and

in which the terms differ in their effect. **Coherence** is the term applied to the wave nature

of laser light. Because laser light is generated by stimulated emission of radiation in a

resonant cavity of fixed length, it consists of a single *wavelength* determined by the

length of the resonant cavity. If the laser light shines on a multi-slit grating then the light

passes through the slits and each slit acts like a separate source. Light from the slits

maintains a constant *phase*-relationship – if there is any change in wavelength, all

contributing sources make the same change together.[56] Note that reciprocally, if there is a

change in frequency (cycle rate, tempo), then all contributing sources make the change

together and maintain their coherence. By strict application, that is all that physics allows coherence. However, the laser is a household item today, and the other properties of laser light may be improperly affiliated with a popular use of "coherence." Laser light is *monochromatic, unidirectional, high intensity, and coherent.* As a metaphorical ensemble, this concept implies ***unity of purpose, intent, and action.*** Note that intent is established in a hierarchically nested fashion, primarily by ***vertical*** informative communication. ***Cohesion,*** on the other hand is a term from materials science. It is a measure of the attraction which binds the basic units of the body in a state called condensed matter such as solids and incompressible liquids. This implies an actual ***physical integrity*** and ***unity of action.*** The difference is that this has been established primarily by ***lateral*** affective rather than vertical informative communication.

When there is a significant change in the state of cohesion in an object – with a resulting change in the physical properties of the object – the change is called a "phase transition." This "phase" that transitions is different from the phase relationship in coherence (see note).[57] It has only relatively recently been applied to military formations, formally introduced by James J. Schneider in "The Theory of Operational Art" in 1988.[58] However, there have been other references to such effects. For Example, General Gavin spoke of "dissolving" units down to the size expendable against a single nuclear blast.[59] According to physicist Raymond Serway, "phase changes in a substance occur when the physical characteristics of the substance change from one form to another. Some common phase changes are solid to liquid (melting), liquid to gas (boiling [or evaporating]), and a change in crystalline structure of a solid."[60] Note that a military contextual connection is possible here in that the properties of matter that describe these phases are the bonding

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strength (its *cohesion*) and the geometry of its ***organization***. For instance, the properties

of solids depend on crystalline structure. A classic example is carbon: The only

difference between graphite and diamond is the crystalline structure. ***Graphite*** exhibits

high anisotropy (properties which differ according to the direction of measurement)

because it is made up of carbon atoms that are,

> strongly bonded to three other carbons in a layer, the bonding angles being 120 degrees
> (the bonds are sp^2 hybrids [covalent, metallic bonds].)... Layers, however, are bonded to
> each other by weak van der Waals' forces [like the weak forces that "attract" water
> molecules to one another in liquid water]... Moreover, it is a useful dry lubricant because
> the layers easily slip over each other."[61]

Diamond, on the other hand, is isotropic because its carbon atoms are strongly

bonded to other carbons in each of the four tetrahedral directions. Diamond structure has

regular crystalline faces, but these are not like the layers of graphite because these faces

(or lattices) in diamond are strongly bonded to one another.[62] The differences in these

crystalline structures can also be described in terms of the energy state of the bonds. The

energy describes how strongly or weakly the atoms are bound together; i.e. it describes

the strength of their ***cohesion***. Phase changes involve a transition to a structure with

stronger or weaker bonds. Metaphorically speaking, the same sorts of phase changes take

place in military formations. Again, these changes involve dependence on the strength

and geometry of ***cohesion***. These variables are easier to describe than to quantify. As for

geometry of cohesion, the effects of the topology of military organization is presented in

theoretical foundations. As an army unit "disintegrates," it becomes less networked and

more crowd-like. It is not easy to quantify the strength of this cohesion, but according to

the accounts of Marshall, Kellett, McPherson, and Sledge, the strength of cohesion

evidently depends on communication – both formal (informative) and informal

(affective).

Kellett discusses the factors that determine cohesion and coherent action. In particular he provides the best description (among the sources referenced here) of the role of leaders in "giving" leadership through "fatherly" affective communication with their soldiers.[63] Another unique observation by Kellett is that unit traditions inform soldiers that incredible personal sacrifice for the unit is expected – it is the behavior modeled by the hero figures found in the *symbols* of tradition and ceremony.[64]

This concept is supported by the claims of S.L.A. Marshall. Regarding cohesion he says, "With the growth of experience troops learn to apply the lessons of contact and communicating, and out of these things comes the tactical cohesion which enables a group of individuals to make the most of their united strength and stand steady in the face of sudden emergency."[65] At least three times he states a principle of complementary support between a unit's fires (which provide collective moral security) and its internal communication which facilitates collective action.[66] He later says, "The full distribution of pertinent information contributes as greatly to defensive strength and to offensive potential as does the proper disposal of weapon power."[67] He also illustrates how the interruption of lateral communication can destroy cohesion: "When an advancing infantry line suddenly encounters enemy fire and the men go to ground under circumstances where they cannot see one another, the moral disintegration of that line is for the moment complete... while erect, they feel the presence of others; when they go down, this feeling is lost... before [the unit] can reintegrate, communication must be restored between the fractions."[68] And he also addresses the differences at higher levels, where physical separation mandates the use of technology to enable communication. He calls information the "soul of morale in combat and the balancing force in successful tactics."

He speaks of communication at this level only in its informative sense, and notes that neighboring companies do not communicate, and information tends to go up, but not to come back down, so the neighbors remain ignorant of (or "invisible" to) one another. He gives four reasons for this effect: "(1)There is lacking a general recognition of the supreme importance of *lateral* flow of information. (2) [higher levels collect but do not distribute information]. (3) Commanders ... [do not] abide by the rule 'when in doubt, pass it along.' (4) Inertia"[69]

James McPherson, author of *For Cause and Comrades,* also goes into great detail explaining the factors in – and implications for leadership that affect – primary group bonding. He also compares this to "regimental" bonding, and in both cases, his description is consistent with Marshall's. However, his description of some of the factors affecting bonding are better described in a "complexity" model like that detailed in appendix 1.[70]

The experience of British Army Major (then Captain) Robert Crisp during operation Crusader in North Africa, 1941, also supports the notion of bond strength due to lateral communication involving affective as well as informative communication. On the tenth day, these were his instructions to his tank commanders as he prepared to take part in an attack on a German convoy along the Trigh Capuzzo: "Listen. This is your first battle. It will probably end up in complete confusion. Keep your eyes on my Honey [tank] all the time. Know where it is all the time and conform to its movements... Got it? O.K. See you at suppertime."[71] In the attack, however, dust from the desert ground obscured his unit's intervisibility, and less than three minutes after the attack began, he had lost control of his unit. There are two significant differences compared to other

sources that should be clarified. First, Crisp's story indicates that the unit (with the exception of his tank) was completely destroyed in 17 minutes, but that was due as much to the relative effectiveness of weapons as to the loss of unit integrity that immediately followed loss of visibility. Second, Crisp's story indicates a significantly lower fear of personal danger than Marshall, McPherson and Kellett spoke of, but in Crisp's case that was due to confidence in the protective armor of their tanks. The purpose of the example here was to illustrate the loss of control. With the loss of visibility (a sensory enabler of both affective and informative lateral communication), positive control became impossible. There was not even a significant effort to organize the fight after it started. From Crisp's perspective, he did not know what he did not know.[72]

The ideas described above demonstrate the importance of both affective and informative communication in military operations. Part of the preliminary hypothesis is a claim that these uses of information determine the military organization's ability to *shape* it future. This leads naturally to the idea that the side of a conflict that is better at these uses might gain a dominance over the other. This side will maintain freedom of action and initiative by achieving "information dominance." This notion is examined below.

INFORMATION DOMINANCE

According to *FM 100-6:*

> Information dominance is defined as—The degree of information superiority that allows the possessor to use information systems and capabilities to achieve an operational advantage in a conflict or to control the situation in operations short of war, while denying those capabilities to the adversary. As we have come to recognize and depend on air superiority as a key condition for military success, information dominance has taken on a similar importance for military operations. *This means that friendly knowledge and understanding of the situation must be more certain, more timely, and more accurate* than the adversary's, revealing to the friendly commander the conditions that will lead to success.[73]

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The *FM* also recognizes that "commanders must be fully prepared to make decisions in an operational environment of ambiguity, characterized by imperfect information and incomplete understanding. [However, the *FM* proposes that] *A goal of IO is to narrow the gap between the art and science of command decision making"[74]* This mentality will *create* the information pathology described by Martin Van Creveld.[75] The doctrinal view of information dominance includes no mention of ensuring superiority in ability to provide affective communication – the very thing needed most under conditions of uncertainty.

Fort Leavenworth's Combined Arms Doctrine Development directorate's White Paper, *Information Dominance*, says:

> Information dominance is a delta: the difference between the aggregate of information available to each of two opposing military commanders. But is more than just information: It's the difference in understanding of information in the context of some specific purpose that is the crux of the definition. Information dominance then refers to a *difference* in what is termed **Battlefield Visualization**... Information technologies will never afford absolute visibility of the battlefield; but, it will be possible to establish dominance by focusing resources at a time and place of one's choosing. Where information is massed in this manner, it will become a catalyst around which other operating systems will get; [sic] and, it will likely set the tempo of battle. The effect of these changes will be to *move battlefield visualization from an intuitive ability towards a science: a deliberate, deductive process* based on the building blocks of raw data, parsed and collated by machines and merged into visual patterns that are presented to commanders as opportunities.[76]

This White Paper appears to describe information acting as a catalyst of coordination between Battlefield Operating Systems, an effect achieved by massing information. This is a cybernetic perspective. The White Paper also goes on to describe "shared visualization" – reminiscent of Senge, but again, the complex concept is presented as if it were a purely cybernetic phenomenon. The White Paper also implies that it is *desirable* to "move from intuitive ability towards ... deliberate, deductive process." The combined research presented in this monograph indicates the opposite. Using the faculty of intuition to make well-informed values-based judgements is the

natural, best way to decide under conditions of uncertainty. Further, this faculty is enabled by affective communication. It is not achieved by amassing data about a guess at where the decisive point will be and getting machines to do the thinking – not in the near-term anyway. It would take a machine that could operate in the affective domain to do the aggregation and evaluation of data that is described in the quote above. The machine would have to have a value system and "emotions" in order to surmount the inevitable uncertainty. And if the machine can do that, why would it need to present the data to a fatigued human commander? Bottom line: artificial cognitive-affective judgement is immature.

All practical decision-making occurs more or less under uncertainty. The apparent mentality behind the current definition of information dominance is the very cause of information pathology. Systems built to seek that kind of dominance will *produce* organizational illness. Against a sufficiently sophisticated adversary, they might not only fail to produce dominance, but even result in paralysis of the friendly force.

To be fair, if the metaphor recognized the cognitive-affective nature of information and communication, then it might be useable. Julian Corbett's "Command of the Sea," which influenced the air superiority concept, considers the sea to be a communications medium that is normally "uncommanded."[77] Maritime assets are "concentrated" to achieve "local command," and air assets are concentrated to achieve local air superiority. It would be a valid claim that a similar concentration of assets could make it possible to "command the communications media" and associated information systems – to ensure the cognitive-affective use of friendly media and systems and deny

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the same to the enemy. However, the current use of the metaphor recognizes only the informative role. So it is currently a bad metaphor.

RAND's Glenn Buchan is also critical of the "information dominance" idea. He says:

> Now, the notion that one should know as much as possible about one's enemies as well as one's own forces while trying to keep the enemy as much in the dark as possible is hardly going to come as a surprise to any student of military affairs. Indeed, Sun Tzu emphasized what amounts to "information dominance" without burdening readers with the jargon. If that is all information dominance means, then *it amounts to a tautology that adds nothing of substance* to contemporary discussions of military strategy and operations.[78]

Buchan also likens the information dominance mentality to the Vietnam era "body count" mentality. He indicates that massing information puts the focus on the wrong part of the problem and promotes "bit count" mentality.[79]

Buchan is also critical of the organizational trend promoted by this mentality – the IO cell. Instead of seeking information dominance, commanders should be asking and seeking answers to direct, meaningful questions. "This will also tend to *disaggregate* disparate elements that are sometimes lumped together … into more logically coherent pieces that can be integrated with other combat tasks into effective operational plans."[80]

SYNOPSIS OF THE METAPHORICAL MODELS DISCOVERED

The next section is a brief synopsis of the metaphorical descriptions of the nature and roles of information in military operations discovered in this research effort.

Physical Principle – This is in fact not a metaphor about information but rather a description of the way in which information *about* something is like a metaphor for that thing. Information is a spatial or temporal ordering of some physical thing in order to represent the spatial or temporal ordering of some other physical thing. Physical communication occurs when a sender orders a communication medium connecting the

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sender to a receiver. The communication medium is a *thing in motion to the receiver that can carry the ordering (information)*. To receive the information, the receiver must be capable of sensing the ordering of the medium. This model explains how information and communication exist and operate in the physical domain. The other models all exhibit a correspondence to this principle in that they explain the effects of the use of information in the cybernetic and moral domains. Therefore, this model is not evaluated as a metaphor. Rather it is used as a basis for the evaluation of the *correctness* and *correspondence* of the other metaphors.

Mass or Energy – This is a physical metaphor, discussed in appendix 1, that expresses the concept that information is a physical thing itself. These physical principles, used as metaphors by DeGroat and Nilsen, are ineffective. They can be effective if used rigorously, as Schneider attempts, but such rigor costs much space and explanation. Further, when used rigorously, they are not metaphors but rather physical principles like those discussed above. Therefore, *mass* and *energy* will not be evaluated beyond the criticism provided at appendix 1.

Information Superiority – This is a concept which originates with the metaphorical belief that information superiority, like air superiority, is possible and desirable. It is expressed in doctrine as *information dominance*. It is essentially a cybernetic model, and it considers only the informative nature of information. It is currently hampered by this, but it could be improved with acknowledgement of the cognitive-affective nature of information.

Commodity – This complex of metaphors explains the effects of the use of information in the cybernetic domain. It includes all ideas associated with the concept

that information is a physical thing that has informative value. Typically these are expressed as aspects of an industrialized economy – such as *extraction* of information from the environment, *processing, packaging, distribution* of information *products, consumption, and* so on. The *information superhighway* and *information infrastructure* are two symbols of the prevalence of this mode of thought. In this model, information is delivered to "consumers" in the cybernetic and moral domains. However, the correspondence is much better with the cybernetic than the moral. It is easier to imagine the value of informative cybernetic *facts* as analogous to monetary value. The same is not true in the moral domain. The closest thing is sentimental value – which is harder to "visualize" as something pertaining to a piece of information.

Social Glue – This metaphor was revealed in this monograph in a quote from Heinz Von Förster, considered by many to be one of the founding fathers of the science of cybernetics. However, it really explains much about the morally *affective* role of communication. Information is still the physical thing transferred in communication, but its informative value is not as great as the affective value of the communication. The latter has greater social influence. The *social glue* concept is attended by several supporting metaphors. *Moral bonding* is a physical metaphor that likens the motivating influences group members have on one another to physical forces. This corresponds well to the notion of *moral cohesion* and parallels the idea of *cybernetic coherence*. However, only if the *bonding strength* of the *glue* is dynamic, as determined by the strength of affective communication, can this metaphor explain the adaptive dynamics of organizations.

Catalyst – This notion represents several metaphors describing the role of information and communication in complex, self-organizing, adaptive systems. Information is the physical thing transferred in informative and affective communication. Organization is the physical structure of systems – the physical interrelationship of group members – used for communication of that information. The notion of communication of information as a *catalyst* represents the concept that group members adapt their organization and their behavior. This adaptivity is based on their cognitive-affective consideration of information and interaction with others. This corresponds well with the *glue* metaphor described above as well as with the ideas that the information itself may be considered a physical commodity. It also corresponds well with Cherry's notion that communication topology (organization) determines behavior.

Medium as Message – This is McLuhan's philosophy that all forms of human interaction can be considered communication and that the media of that communication determine the structure and form of interaction. This corresponds well with Blanchard's notion of "coupling" and with the topological determinism described as a feature of information and communication as a *catalyst,* above. In fact, "metaphorical" correspondence is built into this philosophy as a basic principle. Every medium of communication contains as its message (represents like a metaphor represents – *or corresponds to*) another medium. The concept of *medium as message* contains the concept of information and communication as a *catalyst,* which in turn contains the concept of *social glue*, which in turn contains the concept of a *commodity,* which in turn contains the concept of information as a *physical principle* – in which information "contains" or represents physical reality.

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Core Functions – This is a composite of many metaphors that describe the actions performed by people and organizations as they use information and communication. Note that this metaphor set is built on the *medium as message* metaphor, so it naturally corresponds to it. It therefore also inherits the other correspondence to the other metaphors that *medium as message* enjoys. However, the revised *core functions* set also enjoys a correspondence with both the core functions pertaining to other aspects of military operations and to the principles of war. They all have the same conceptual roots.

EVALUATION CRITERIA

The summary below provides the basic definitions of the evaluation criteria. Complete descriptions are provided at appendix 3. These criteria are designed to evaluate instances of metaphor in military theory and doctrine in the context of 1998 reality and the analytical framework established in the Advanced Military Studies Program at the US Army Command and General Staff College, Fort Leavenworth, Kansas. The evaluation judges the justifiability and the general utility of such metaphor. Therefore applying the criteria does more than validate a hypothesis (that a particular metaphor is valid). It also judges the utility (that the metaphor is good). Note also that because the 1998 context is used for evaluation, the question is not whether the metaphor was good when the author used it; it is whether the metaphor is good today (and likely to remain good).

FIDELITY – The metaphor should be rigorously derived and developed. *Formulation* – Can an image or mathematical representation be extracted from the metaphor? (Yes is good.) *Correctness* –Are the principles in the metaphor cited correctly and used appropriately? (Yes is good.) *Completeness* – Has the formulation been well developed? (More is better.) *Correspondence* – Does the formulated

description correspond with a proper scaling of other generally accepted models? (Yes is good.)

COMMONALITY -- The metaphor should be common enough in its expression to serve reliably as a basis of common experience for the military lay-readership. *Reliability* – Has the metaphor been used in the same way by many independent authors over a long period?[81] (More is better.) *Simplicity* – What level of study is required to comprehend the metaphor? (Less is better). *Ambiguity* – Is the common experience attached to the metaphor single-valued? (Yes is good).

EVALUATION OF SELECTED METAPHORS

The metaphors identified above in the synopsis are evaluated in tabular format in appendix 4 using the evaluation criteria established above.

CONCLUSIONS AND IMPLICATIONS

CONCLUSIONS

There is no elephant.

The various metaphors for information apply under different conditions and in different ways. However, it is possible to improve the contemporary view of the cognitive hierarchy and to use the method of J.F.C. Fuller to establish a unified, coherent system of thought regarding the nature and role of information in military operations. This unified perspective demonstrates the correspondence and reconciles the apparent differences between the various metaphors.

The various metaphor are evaluated above using this approach. The conclusions of this evaluation follow:

Information Superiority is currently a bad metaphor. It considers only the informative nature of information, ignoring the affective nature. It also promotes inappropriate aggregation of functional proponents in an "IO cell." Further, it promotes a "bit count" mentality that distracts attention from the relevant questions themselves.

Commodity is a good metaphor by the evaluation of *all* these criteria. Perhaps its most useful feature is the good correspondence it enjoys with the newer, more complex metaphors. Thus it is a good tool for explaining them.

Social Glue is a good metaphor. It is somewhat abstract and cannot completely describe the nature and causes of moral bonding, but it corresponds well with other metaphors.

Catalyst is a pretty good metaphor. It is somewhat superficial, but it helps to describe the dynamic nature of organizations that the social glue metaphor cannot.

Medium as Message is a good metaphor (or perhaps even a physical principle). However, it is relatively abstract and complicated. It is not well known and understood. As a result, it may have utility unifying the ideas of academics or deep thinkers, but it is unlikely to be of direct utility for communicating with the average layperson.

Core Function is an excellent metaphor-set. It evaluates well with *all* of the criteria above. It corresponds well with each of the other metaphors described. However, it also uniquely adds a correspondence to other aspects of military operations and to the principles of military operations that other metaphors do not. Some of the other metaphors are better at describing specific perspectives, but these *core functions* are the basis of a coherent system of thought. As such, it provides a uniform perspective from

which to enable the reconciliation of apparent differences between the other models of the nature and role of information in military operations.

IMPLICATIONS

Doctrine articulates how and what the military community thinks about its profession. This study has demonstrated two significant deficiencies in that collective representation of military thought. First, the affective role of information and communication – its role in the moral domain – is neglected. There is a schism between leadership doctrine and command doctrine when in fact, both should recognize the requirements for affective as well as informative communication. Second, the doctrinal articulation of core functions could be improved. While the emerging capstone Army doctrinal manual, *FM 100-5 (Revised Final Draft, 1998)* improves the good beginning established by its 1997 predecessor, it still originates from the insufficient *economy of force* paradigm of J.F.C. Fuller. The revised set of core functions presented in this study offer further improvement.

Training and Organization all current combat training simulation systems function in a command environment of perfect communication. Even the combat training centers offer unhampered communications at echelons above the brigade combat team. This "unrealism" means that emerging organizations and the techniques and procedures they employ are not properly validated by this training. This study indicates that the very notion of "information dominance," that units are beginning to train themselves to achieve, is a misplaced goal. Instead, units should train in simulations and centers where controllers deliberately *deny* communication to portions of the force. This is the only way, without actually fighting an enemy or operating in a sufficiently hostile

environment, to examine the effects of information and communication – or the loss of it – on organization and organizational effectiveness.

Materiel – The Army is currently acquiring materiel which supports the "information superiority" paradigm of minimizing uncertainty. This is an inappropriate goal. This study indicates that a better approach would be to acquire systems which *facilitate* decision-making under uncertainty by providing the affective communication necessary to implement a decentralized command structure that can exhibit coherent action. Informative communication, like that exemplified by computer-to-computer transfer and automatic data-fusion, is still required. However, communication systems that enable affective communication – the ability for humans to motivate and emotionally influence one another – are also required.

FURTHER RESEARCH

This study has been designed *not* to answer any one specific question in the areas where its findings have implications. Instead, this study answers a question *fundamental* to all work in those areas. Therefore, it can serve as a foundation for a wide variety of further research projects. In each of the areas listed above there are economic concerns about the best way to appropriate resources. Those questions can now be addressed with a fresh perspective.

The following are examples of such questions: "what is the optimal number of subordinate commands?" or "what is the optimal degree of mesh-like interconnectedness for a military organization?" or "Is this inhomogeneity in organization introduced by Video Tele-Conferencing a good thing?" or "Is the affective communications gain achieved with one "hot" VTC worth the loss of a dozen relatively "cool" telephone

channels?" or "Is the VTC important enough to allocate lift assets to move the required equipment ahead of other important weapon systems?" or "Will VTC cause rather than ease the "information pathology" of Martin Van Creveld?"

In its expression of the revised set of core functions, this study has generated a new arrangement of what could potentially become doctrinal terms. The specific word choice has been carefully considered. However, other choices are possible and could potentially adjust the relationships involved. An optimal set of core function verbs is a worthy goal for further work.

APPENDIX 1 – THEORETICAL FOUNDATIONS – IN DEPTH

This appendix provides a full exploration of the theoretical foundations of this monograph. This is essentially a critical review of the literature. It begins with a synopsis of the author's earlier work, of which this monograph is an extension. Then it establishes a general framework for consideration of the research question. Next it reviews several of the various perspectives that respected authors use to look at the question and attempt to answer it. Finally, since there is no single, satisfactory answer in the literature, J.F.C. Fuller's *The Foundations of The Science of War* is reviewed as a method for establishing integrative principles.

THE ROLE OF METAPHOR IN MILITARY THEORY AND DOCTRINE

The following is a synopsis of the Theoretical Foundations of this author's earlier work, *Physical Metaphor In Military Theory and Doctrine*. It enables the extension of concepts established in the earlier work and makes it possible for the current monograph to stand alone.

MILITARY THEORY AND DOCTRINE: AUTHORITATIVE BASIS FOR COMMON ACTION

Doctrine provides the authoritative stability required for common aim and action in the present and for some finite period into the future – in order to minimize surprise that future changes might create.[82] Its development is a complex process. Countless different authors form sets of "justified true beliefs" into different theories. Fortunately, while theories justify the *beliefs* of their adherents, they have no authority to direct their *action*. Military activity demands an ***authoritative basis for common coherent action*** – a common coherent system of thought. Doctrine provides this by requiring perpetual drafting and staffing in a formal process for approving changes. As an authoritative

source, doctrine also strives to remove the confusion that surrounds the development of new ideas.

Authors of military theory and doctrine frequently use metaphor to communicate their ideas.[83] Therefore, it is important to understand what a metaphor is and how metaphorical communication works.

METAPHOR AND METAPHORICAL COMMUNICATION: A DOUBLE-EDGED SWORD

According to Websters:

> **Metaphor** ... [from the Greek] meta- [BEYOND, TRANSCENDING] + pherin to bear. **1 :** a figure of speech in which a word or phrase literally denoting one kind of object or idea is used in place of another to suggest a likeness or analogy between them (as in the ship plows the sea) <using ~, we say that computers have senses and a memory – William Jovanovich>; broadly : figurative language – compare SIMILE ....[84]

As Libicki indicates above, metaphors serve professional communities by providing a basis for common understanding of new mental models. They are the foundations of new paradigms – the core ideas upon which theories are built and therefore from which doctrine is developed. Note the defintion:

> **paradigm** ... noun **1.** An example that serves as pattern or model. ... [Middle English, example, from Late Latin paradigma, from Greek paradeigma, from paradeiknunai, to compare : para-, alongside. See para-' + deiknunai, to show.] [85]

Metaphor are the "ways," paradigms are the "means," and new theoretical understanding is the "ends." The mechanics by which metaphors accomplish this task is more than simple linguistic translation, though. They are, so to speak, our mental "super-models." Using the well-known terminology of Bloom's *Taxonomy of Educational Objectives*, they operate in *both* the "cognitive" and "affective" domains.[86] As a result, metaphors are both highly capable and rather dangerous tools.

Metaphor is a two-edged sword. It evolves the language by bringing new meanings to words and expressions when they are used in new contexts. However, this

process tends to diminish the precision of the language, and the loss of precision can lead to degeneration of the language. As General Donn A. Starry, Commanding General, U.S. Army Training and Doctrine Command (TRADOC), began his *Commander's Notes, no. 3*, on 23 February 1979:

> All professions have vocabularies of professional terms. Over time, many such terms become establishment "in-words," and are so ill-used that their original meaning is lost. Often it is only necessary to use the words to evoke affirmative head nodding; even though no meaning is conveyed, everyone professes to understand what is meant.[87]

The vitality of the language is thus the users' responsibility. Jacques Barzun and Henry F. Graff comment on this in *The Modern Researcher*. They explain three methods to ensure an intended meaning is conveyed successfully in writing. First, "the two straight roads to meaning are, on the one hand, simple particulars and, on the other, careful generality."[88] Then, since such writing is lifeless and boring, they offer a third method: "The road of imagery, the third, is the winding and dangerous one."[89] Thus they describe metaphorical communication metaphorically. Specifically, this model of communication treats the "content" of the metaphor as a "commodity." It is relatively easy to follow: There along Barzun and Graff's "winding road" – whereby authors use imagery to deliver meaning – is the traffic of metaphor. Some of the sturdy trucks faithfully deliver their cargo (meaning), but others break down, collide, get lost, or go off the road, taking their cargo with them.

The utility of Barzun and Graff's "winding road" is limited, however. S. I. Hayakawa describes how language carries meaning in more detail. In *Language In Action* he describes communication involving both "informative" and "affective" uses of language. "Informative language" is "symbolic." It uses things (words) which "stand for" other things (objects).[90] "Affective language" is "presymbolic." It is human

communication *expressing* the speaker's internal conditions rather than *reporting* them. Social interaction such as verbal greeting, flirting, arguing, or fighting often involves this kind of language. The sounds of the words (the symbols) have little or no real meaning attached to them, but they are completely successful in the way they affect their recipient. Hayakawa describes generalized "Affective Communication" involving both the affective and the informative connotations of words.[91]

Colin Cherry takes a similar view in *On Human Communication*. Cherry says "metaphor plays a most forceful role, by incorporating ideas through a vehicle language, setting up a linguistic association... Metaphors arise because we continually need to stretch the range of words as we accumulate new concepts and abstract relationships."[92] Cherry goes on to quote Ogden and Richards' *Meaning of Meaning*, describing the linguistic view of communication as both "symbolic" and "emotive." These categories correspond well to Hayakawa's informative (symbolic) and affective (presymbolic) communication.[93]

Dietrich Dörner looks at metaphor *post reception* – in its *cognitive* role. In his book, *The Logic of Failure*, he describes a generalized planning process in which "we don't *do* anything; we just consider what we *might* do. The essence of planning is to think through the consequences of certain actions and see whether those actions will bring us closer to our desired goal."[94] His description is similar to the Military Decision-Making Process (MDMP) described in US Army *Field Manual 101-5: Staff Organization and Operations*.[95] Both Dörner's planning process and the MDMP apply an "analytical approach to problem solving."[96] In Dörner's vocabulary, this analytic approach is an investigation into a sector of reality – what he calls a "problem sector." During this

process, the scope of the investigation (the size of the "problem sector) is limited so time is not wasted. However, this limitation occasionally produces no solution, and the sector must be "widened" again. "Thinking by analogy," says Dörner, is an effective way to "widen the problem sector."[97] In thinking by analogy (metaphor or simile) one can gain insight into the dynamic complexity of a system and the inter-relationships of its critical variables. The new insight is synthesized as concepts known *a priori* are applied categorically (metaphorically) to new situations. To the degree that one is justified in the new beliefs resulting from this insight, they constitute new knowledge.[98] This is some kind of a *cognitive* event.

If one connects both the *communicative* models of Barzun and Graff and Hayakawa with the *cognitive* model of Dörner, the result is a notion of communication that involves the receipt of one meaning and results in the synthesis of another. The recipient derives meaning from the linguistic symbolic (informative or *rational*) and emotive presymbolic (affective or *emotional*) content of the metaphor. Curiously, however, since the "traffic" was a metaphor rather than a direct linguistic representation, once the new meaning is realized, the metaphor may no longer be necessary to sustain it. In fact, if the inductive leap goes far enough, the metaphor may not even be *sufficient* to sustain the new knowledge. According to John Casti, author of *Complexification*, this is the conclusion Ludwig Wittgenstein eventually reached.[99] Casti quotes Wittgenstein:

> My propositions are elucidatory in this way: he who understands me finally recognizes them as senseless, when he has climbed out through them, on them, over them. (He must so to speak throw away the ladder, after he has climbed up on it.) He must surmount these propositions; then he sees the world rightly.[100]

Wittgenstein's metaphor of throwing away the ladder is a concise statement of a completely different epistemological concept.[101] It illustrates, by its own example, what

happens in metaphorical communication. Once the metaphor has elucidated meaning for the reader, it is no longer needed. This clarifies Hayakawa's claim that metaphor is "among the most useful communicative devices," since it permits language to "grow and adapt to our changing needs."[102] Metaphor is, so to say, the catalyst of emerging knowledge.

However, this ability is not used without danger. Focusing on the "dark side" of cognition, Massimo Piattelli-Palmarini explains the danger as that manifest in what he calls "cognitive illusions" or "mind tunnels."[103] The very same faculties which enable metaphorical communication evidently make humans susceptible to "mistakes of reason." This sort of human judgement is evidently non-rational, though often subjects are convinced their decisions *are* rational. As he points out in *Inevitable Illusions*, "Cognitive illusion is not an ordinary blunder; it does not originate in guesswork but from the formulation of a potent although mistaken intuitive judgement that, at least at first sight, convinces us within ourselves."[104] Piattelli-Palmarini describes eight kinds of "mind tunnels" associated with seven "deadly sins" of everyday irrationality or judgement under uncertainty. Metaphorical communication and metaphorical mental modeling can facilitate three of these sins. The first, which Piattelli-Palmarini calls "magical thinking," is dangerous because readers are likely to believe false claims based on a metaphor that seems coherent with their other beliefs – regardless of the truth. The second, "ease of representation," is dangerous because readers are likely to believe a claim to be true *in general* when it is presented with or as an emotive metaphor – despite the actual falsity of the claim in most circumstances. Third, "reconsideration under suitable scripts," makes metaphor dangerous because it can strengthen some links of an

argument, in which other links are weak. Thus, the metaphor makes the whole argument *seem* stronger, when in fact it *cannot* be.[105]

The double-edged feature of metaphor also means that the result of a reader's cognition is not completely certain. Two readers could be affected differently by the same metaphor and thus receive different meanings. However, as readers share their views about what they have read, their dialogue will result in a better collective understanding. They synthesize new knowledge in two stages. First, they read it and glean their own understanding. Then they share and improve their understanding. So, the degeneration of the language is partially counteracted – as long at the readership interacts to build a "shared vision" like a complex, adaptive, self-organizing system.[106] That is why it is good to share ideas about the content of military doctrine.

FROM INFORMATION TO UNDERSTANDING: UNDERSTANDING "INFORMATION"

THE "COGNITIVE" HIERARCHY

The figure on the right is like Figure I-3, entitled "The Cognitive Hierarchy," in the Joint Chiefs of Staff's *Joint Pub (JP) 6-0, Doctrine for Command, Control, Communications, and Computer (C4) Systems Support to Joint Operations.*[107] According to *Joint Pub 6-0,*

> "**Information is data** collected from the environment and processed into a usable form... **Combining pieces of information with context produces ideas or provides knowledge.** By applying judgement, knowledge is transformed into understanding."[108]

THE COGNITIVE HEIRARCHY

UNDERSTANDING

JUDGEMENT

KNOWLEDGE

COGNITION

INFORMATION

PROCESSING

DATA
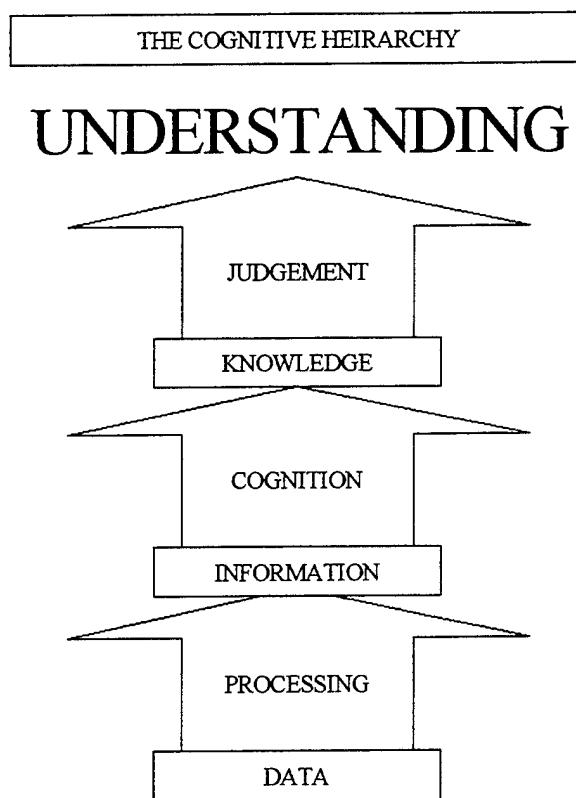
This is a rather ambiguous and simplistic description of core concepts. US Army

Field Manual (FM) 100-5, Operations (Final Draft) and *FM 100-6, Information*

Operations also contain this sort of diagram as Figure 19-2 "The Cognitive Hierarchy

and the Art of Operations" and Figure 2-1 "The Cognitive Hierarchy" respectively.[109]

The *FM 100-5* version is below:
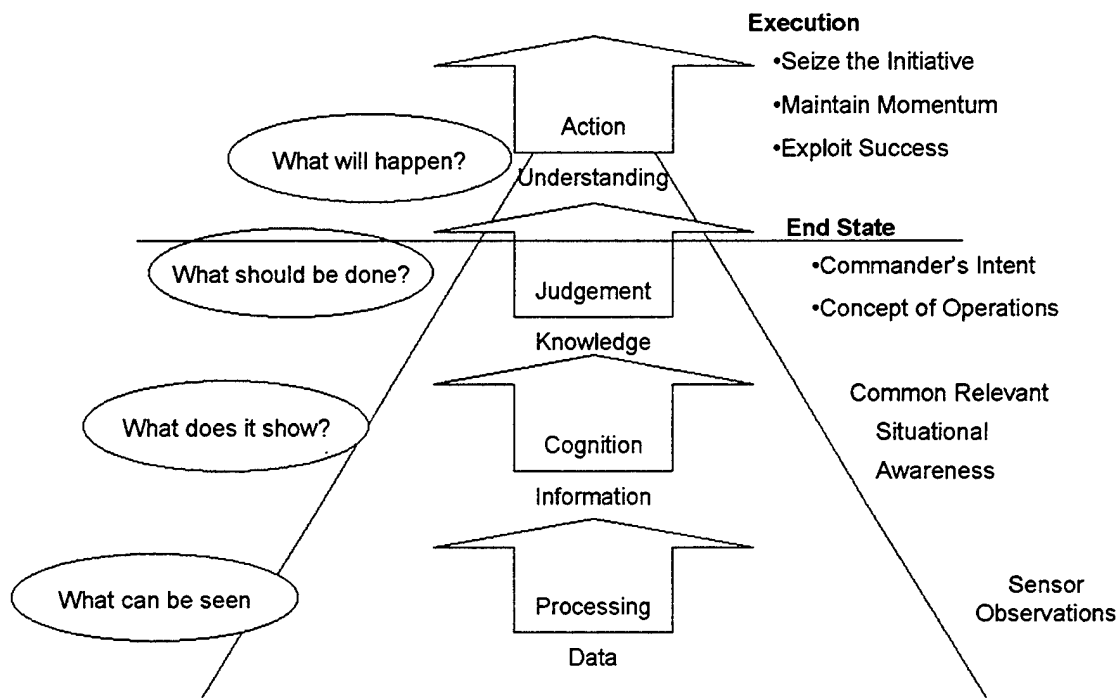
The *FM 100-5* description is more complete than that in *JP 6-0*. However, both

publications necessarily protect their readers from the underlying studies of information,

communication, and cognition, and the resulting presentation is incomplete. They are

concerned only with the "cognitive domain," but they ignore the "affective domain"

altogether. In so doing, their treatment of the fundamentals is rather superficial and thus

exposes some of the core concepts to distortion.

Both models above describe the cognitive process of an isolated individual.

However, no one really lives in total isolation. Man is a social creature. While this is the

source of conflict in some ways, it also facilitates problem solving in another. Man need not solve problems alone. In the military environment, soldiers communicate to share their understanding so they can solve problems *collectively*. Different communications help to do this in different ways. These are discussed in more detail later. For now, it is important to understand that the "bottom" of the cognitive hierarchy is not simply *informative* "data." There is also an *affective* role to the communication of information. Therefore, it is important to examine these two roles more closely.

BLOOM'S TAXONOMY: COGNITIVE AND AFFECTIVE DOMAINS

Benjamin S. Bloom and an extensive panel of respected educators began work on *Taxonomy of Educational Objectives* in 1948. Their initial purpose was to create a common set of terms "for describing and referring to the human behavioral characteristics [they] were attempting to appraise in [their] different school and college settings."[110] Their work *Handbook I: Cognitive Domain*, published in 1956, was very successful. In 1964 it was joined by their second work *Handbook II: Affective Domain*. They were far less satisfied with the second work.[111]

The concepts of cognitive and affective domains resonate with the concepts of informative and affective communication developed in the discussion of metaphorical communications above. Also, the development of understanding *is* education, and it is essential to good decision-making. Therefore, these ideas are important not only in understanding educational objectives, but also for understanding communications for collective problem solving (or any field involving communication). These concepts and the related definitions are the accepted basis for reference regarding the use of these terms in the manner necessary in this monograph. It is therefore important to review the

vocabulary and the structure established by the *Taxonomy*. This will facilitate the

synthesis of a conceptual model that fixes the "cognitive hierarchy" of US military

doctrine using appropriately accepted terminology.

The Cognitive Domain deals "with the recall or recognition of knowledge and the

development of intellectual abilities and skills."[112] Only the major classes are listed

below:

1.0 Knowledge
"Knowledge, as defined here, involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting."
    1.1 Knowledge of Specifics
    1.2 Knowledge of Ways and Means of Dealing with Specifics
    1.3 Knowledge of the Universals and Abstractions in a Field

2.0 Comprehension
"This represents the lowest level of understanding. It refers to a type of understanding or apprehension such that the individual knows what is being communicated and can make use of the material or idea being communicated without necessarily relating it to other material or seeing its fullest implications"
    2.1 Translation
    2.2 Interpretation
    2.3 Extrapolation

3.0 Application
"The use of abstractions in particular or concrete situations."

4.0 Analysis
"The breakdown of a communication into its constituent elements or parts such that the relative hierarchy of ideas is made clear and/or the relations between the ideas expressed are made explicit."
    4.1 Analysis of Elements
    4.2 Analysis of Relationships
    4.3 Analysis of Organizational Principles

5.0 Synthesis
"The putting together of elements and parts so as to form a whole... in such a way as to constitute a pattern or structure not clearly there before."
    5.1 Synthesis of a Unique Communication
    5.2 Production of a Plan, or Proposed set of Operations
    5.3 Derivation of a set of Abstract Relations

6.0 Evaluation
"Judgements about the value of material and methods for given purposes. Quantitative and qualitative judgements about the extent to which material and methods satisfy criteria."
    6.1 Judgements in terms of Internal Evidence
    6.2 Judgements in terms of External Criteria

Cognitive domain communications facilitate collective problem solving in a

rational, informative way. The military doctrinal models of cognitive hierarchy support

this idea, and there is a rough correspondence between levels. The military models start

with data and call "cognition" the process of developing knowledge. This gets them to

level 1.0 of the taxonomy. Then the military models call "judgement" the process of

developing understanding from knowledge. The taxonomy breaks out several

intervening levels of cognition (comprehension, analysis, application, and synthesis)

before it gets to "evaluation" where "judgement" is involved.

The Affective Domain concerns "objectives which emphasize a feeling tone, an

emotion, or a degree of acceptance or rejection."[113] Only the major classes are listed

below:

1.0 Receiving (Attending)
"At this level, we are concerned that the learner be sensitized to the existence of certain phenomena and stimuli; that is, that he be willing to receive or to attend to them.."
    1.1 Awareness
    1.2 Willingness to Receive
    1.3 Controlled or Selected Attention

2.0 Responding
"At this level we are concerned with the responses which go beyond merely attending to the phenomenon. The [recipient] is sufficiently motivated that he is not just 1.2 Willing to attend... and is actually doing something with or about the phenomenon"
    2.1 Acquiescence in Responding
    2.2 Willingness to Respond
    2.3 Satisfaction in Response

3.0 Valuing
"This is the only category headed by a term which is in common use in the expression of objectives by teachers. Further, it is employed in the usual sense: that a thing , phenomenon, or behavior has worth. This abstract concept of worth is in part a result of the individual's own valuing or assessment, but it is more a social product that has been slowly internalized or accepted and has come to be used ... as his own criterion of worth."
    3.1 Acceptance of a Value
    3.2 Preference for a Value
    3.3 Commitment (Conviction, Certainty)
        "Belief at this level involves a high degree of certainty. The ideas of 'conviction' and 'certainty beyond a shadow of a doubt' [convey this]. **Loyalty to a position, group, or cause would also be classified here***... He acts to further the thing valued in some way... There is a real motivation... "*

4.0 Organization
"As the learner successively internalizes values, he encounters situations for which more than one value is relevant. Thus the necessity arises for (a) the organization

of values into a system, (b) the determination of the interrelationships among them, and (c) the establishment of the dominant and pervasive ones."

    4.1 Conceptualization of a Value

    4.2 Organization of a Value System

5.0 Characterization by Value Complex

"At this level of internalization the values already have a place in the individual's hierarchy, are organized into some kind of internally consistent system, have controlled the behavior of the individual for a sufficient time that he has adapted to behaving this way; and an evocation of the behavior no longer arouses emotion..."

    5.1 Generalized Set (orientation, predisposition)

    5.2 Characterization (by world-view)

Affective domain communications facilitate collective problem solving because they develop the value system. The military models do not account for this at all. However, at the lower levels, they enable the problem solver to be aware of and respond to situations in a non-rational way. Also, at the higher levels, the collective normalization of value systems provides for the commitment and motivation necessary to experience the cohesive effects described as a "moral domain" phenomenon. Both of these abilities are critical to leaders. ***Commanders provide affective communication to motivate and maintain cohesion, and they receive affective communication to solve problems under uncertainty.***

The cognitive and affective domains are not the only way to classify communication. Several other models are presented below.

CLASSICAL THEORIES OF INFORMATION AND COMMUNICATION

COMMUNICATION: FROM SYMBOL TO COGNITION

Any practical theory for the use of information in the military (or any other organization) will necessarily describe information in the context of communications. The organization must act collectively to solve its problems – to adapt to its environment and to achieve its purposes. This means the individuals within the organization must share information, and that means they must communicate. It is therefore important to

1-12

clarify the relationship between information and communication. So, to that end it is important to introduce a generalized communications model at this point. Entire books have been written about this subject; the description below is a unified overview of the critical ideas presented in several such texts.[114] "Generalized" means that the model applies to all forms of communication, not just the linguistic communication discussed previously, where the role of metaphor was the focus. Communication is manifest in many forms. *Inter-personal social* forms are communications between individuals such as letters, phone calls, whispers, "posturing," and even fighting. These *normally* exhibit simultaneous bi-directional "information" exchange. That is, there are actually two "links" open at the same time; even when one person "speaks" the other "responds" non-verbally. *Governmental social extensional* forms are communications used to govern collective behavior in groups. This form includes written laws, policies, regulations, and doctrine; command and control communications; organizational meetings or discussions; civil-military affairs; psychological operations; collective civil demonstrations; military demonstrations; and even military fighting. These are normally considered uni-directional communications with an individual or a group attempting to extend its influence in/on another group or groups. There are other perspectives though. For example it is easy to imagine law-enforcement and civil-demonstrators engaging in bi-directional communication, or one can imagine that a "State Of the Union" address might be *Omni-directional*. *Sensory* observation is not necessarily communication."[115] Examples include seeing, hearing, feeling, reconnaissance, surveillance, and target acquisition; but the object of observation determines whether the process should be called communication. As the Latin root of the word indicates, there must be at least two intelligent co-

municants to operate a communication channel. So, if one is observing purposive human activity, one might call the observation a form of uni-directional communication. However, it is a *loose* application of the term, and the process is not *linguistic*. Therefore it involves not symbol-to-sign encoding and sign to signal assembly, but "presymbolic" information-to-signal encoding (these encoding concepts are further clarified below). On the other hand, if one is observing raw natural phenomena, there is no intelligent communicant at the originating end of the link In such links "nature" originates unbiased non-purposive information about itself with no "intent" whatsoever. From "nature's view" these are omni-directional originations, but from any particular observer's perspective, they are strictly uni-directional. Note that "extended" reconnaissance systems involving human observers are not strictly of the sensory type. They are hybrids including sensory links and one of the other types.

Jagjit Singh, author of the 1996 text *Information Theory, Language and Cybernetics* describes a generalized communication system with a diagram similar to the one below.[116]
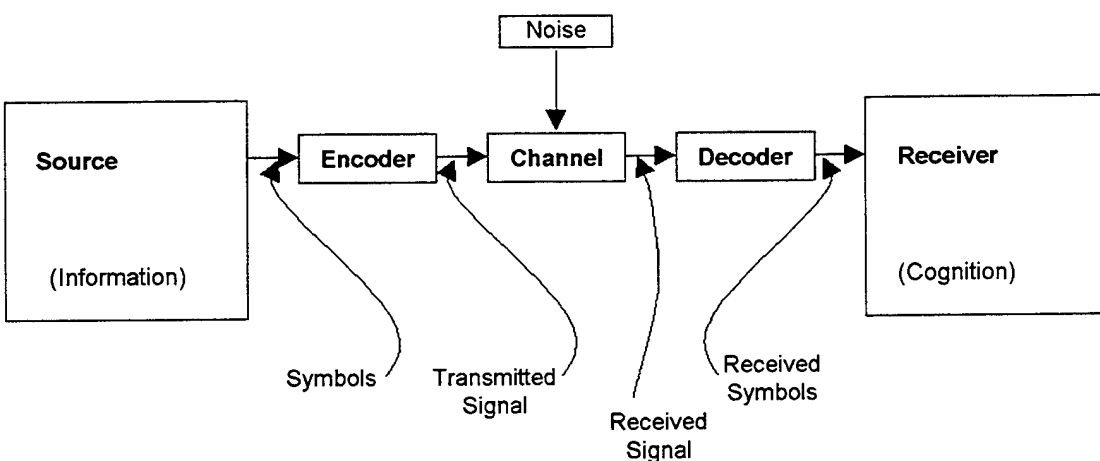
Note that this is a *generalized* model. In multi-party communication, there might be two channels of this sort, one in each direction, between every pair of participants. Alternatively, there might only be one "channel." Then each participant continuously decodes and receives from the channel and contends with all the others for access to the channel in his "turn" at transmission. This communications model, unlike that presented earlier which specifically dealt with the use of metaphor, is sufficiently general for the introduction of features of telecommunications systems.

A cognitive-linguistic model of communication has all the features of the Barzun and Graff, Hayakawa, Dörner, and Wittgenstein models discussed earlier. The following description establishes the definitive use of the otherwise ambiguous labels for the parts of such systems. "Cognitive" indicates that the source purposively formulates, and the receiver cognitively judges the content of a message. "Linguistic" indicates that the message must be formulated using the linguistic symbols (normally words for humans, probably binary digits for computers, etc.) available to the source. "Cognitive-linguistic" differs from the classical linguistic model in that it is possible to know some things (have some meanings in mind) that it is *not* possible to represent with the linguistic symbols available (that you cannot articulate). It is therefore impossible to formulate a "perfect" message. A "cognitive-presymbolic" model would allow non-linguistic communication through the encoding of presymbolic information, such as a metaphor might convey.

Obviously, it would be possible to describe a model without using the "big words" above, but it would be counterproductive. Any further abstraction (which would be required) would hide significant features of the model and thus allow them to escape

undefined and ambiguous. The goal here is to eradicate ambiguity in the context of this study.

One point of ambiguity in the literature concerns the distinction between the formulation of the message described above and the encoding described below. In this model, *expression* is the process by which the source formulates a *message* consisting of a set of *symbols*. A message is prepared for transmission as its symbols are *encoded* into *signs*. Note it is <u>not</u> possible to have communication without encoding. Signs are physical things that physically travel the channel. For example, in face to face verbal communication, the words (symbols) used are strictly linguistic, the speech is the process through which words are encodes using sounds (physical compression waves travelling in the air) to represent the words. The sound of a word is a sign. An aggregate string of signs is a *signal.*

There may be several nested layers of encode/decode processes. On one hand, encoding may include a means for ensuring efficient use of the finite "capacity" of the channel. Military "Brevity Codes" and data compression schemes serve this purpose through *reduction* of *redundancy* in any non-random signal. On the other hand, encoding might also include *introduction* of *redundancy* since the channel is never perfect. Modern modems typically perform both of these encoding functions to optimize the redundancy based on the quality of the channel. Encoding may also include encryption. Often an encoded signal cannot travel the distance to the receiver through a *passive* channel such as the air or a wire. Then the signal may be further encoded and placed on an *active* channel like AM or FM radio by a process called *carrier modulation.*[117]

No matter what kind of encoding – and no matter what kind of channel is used – noise always interferes with the accurate reception of the signal. Therefore the received signal is never entirely the same as the transmitted signal. The depiction of noise only affecting the channel (in the diagram) is a reasonable simplification of reality. Noise interferes with all of the constituent processes by which the sender tries to make information become knowledge in the receiver's mind. Types of noise range from electromagnetic to audible to physiological. Manifest examples range from electromagnetic jamming to the "hum" of a busy office to indigestion.

Decoding is approximately the reverse of encoding. Decoders may be able to recover the entire message if there is enough redundancy in the received signal for the decoder's error-correction to overcome the corruption of signs due to noise.

In cognitive models of communication, the receiver doesn't really "have" the message until after judging the meaning of the received linguistic symbols. However, the cognitive receiver may be able to make such a judgement even when the whole message has not been received. This happens quite frequently in day-to-day life as one can "glean" what someone else is speaking about even when one cannot hear everything said.[118]

This communications model and the cognitive hierarchy preceding it are now a basis for understanding the "information" theories below.

THE "MEANINGLESS" MODEL: INFORMATION AS A PRIMITIVE PHYSICAL CONCEPT

According to Webster's, there are nine definitions for information:

in for ma tion ... **1** : the communication or reception of knowledge or intelligence **2 a** : knowledge obtained from investigation, study, or instruction **b** : INTELLIGENCE, NEWS **c** : FACTS, DATA **d** : a signal or character (as in communication system or computer) representing data **e** : something (as a message, experimental data, or a picture) which justifies change in a construct (as a plan or theory) that represents physical or mental

experience or another construct **f** : a quantitative measure of the content of information; specif : a numerical quantity that measures the uncertainty in the outcome of an experiment to be performed **3** : the act of informing against a person **4** : a formal accusation of a crime made by a prosecuting officer as distinguished from an indictment presented by a grand jury.[119]

Evidently information means whatever you want: definitions 1, 3, and 4 are verbs.

Definition 1 implies naively that one can treat *knowledge* or intelligence like a commodity and transport it *directly*. 2 a *equates* information to knowledge. 2 b equates it to intelligence. 2 d equates it to a *signal* (i.e. information represents data). 2 e. equates it to the *data*. 2 f says it quantifies uncertainty. Here is a manifestation of the "degeneration" in language Barzun described. The inherent ambiguity in a term with nine definitions, each of which uses other equally ambiguous term, makes rigor very difficult. Enter Shannon.

In 1948, Claude E. Shannon published "A Mathematical Theory of Communication" in The Bell System Technical Journal and introduced the world to a quantitative "Information Theory."[120]. In 1979, Myron Tribus, who was a student of Shannon's in 1961, co-edited *The Maximum Entropy Formalism*, a collection of papers presented at a Massachusetts Institute of Technology conference on the influence of Shannon's theory in various fields. In his introductory article, Tribus explains the Shannon's Information Theory and the later extension of Shannon's ideas by Edwin T. Jaynes, resulting in *The Maximum Entropy Formalism*. Tribus says Shannon called the mathematical function he used to quantify the randomness of a message "Entropy" because it was the same function used to calculate entropy in thermodynamics.[121]

For Shannon, Tribus, and Jaynes, entropy measures the reducibility of a message. Cyclic patterns of symbols (redundancy) in a message can be reduced if the originator presents the pattern only once and indicates how many times to use it. Once all

redundancy has been eliminated, the finite length of the string of symbols in the message is the minimum. From a communications system's perspective, the difference in the number of symbols in the original message and the completely reduced is channel capacity that can be "tapped" by using it for part of another message. In this sense, the entropy or reducibility of the message becomes the potential availability of the channel.[122]

In thermodynamics, entropy is a state variable – it describes the "state" of a system. In a gas, the entropy describes the state of uniformity or randomness in the activity of the particles of the gas. Whenever the system has either a higher temperature than its surroundings or a configuration other that the most uniform and random, there is energy in the system that "wants to get away." Letting this energy go increases the entropy because the randomness increases.[123]

The uniformity between Shannon and Thermodynamics is in this notion of *state* and the notion of the quantity of entropy can help one calculate the availability of something. The state of a system is a description of the relationship between its constituents, and the relationship can be complex. In the second paper in *The Maximum Entropy Formalism* papers, Jaynes says, "the essence of the principle is just:... [Entropy] is just a means of describing a certain *state of knowledge*"[124] In thermodynamics, entropy describes the phyical state of the system. In information theory, the thing "available" is potential channel capacity; in thermodynamics the thing available is "free" energy. Tribus and Jaynes argue that if you take "information" as they define it to be a primitive concept, then the physical form is derivable from it[125]. Thus, it is legitimate to consider the difference to be semantic.

The debate about the "entropy" of information theory is really more a problem with the definition of "information" than it is of math, physics or any other discipline. Note that Jaynes' quote above does not indicate that quantifying the "information" in a message tells you anything about the *meaning* of message. That is why this model is called the "meaningless" information theory in this monograph. The entropy of a message tells you *how much* information it contains. But it tells you nothing about *what* information is in the message.[126]

The problem arises when one confuses the information with that which can quantify it entropy, as is evident in conversations like this: A: "What's the information in that message?" B: "Ahh, 2.3 bits per symbol." (a legitimate use of the word according to Webster's definition 2 f above). Singh (a cybernetics expert) and J. R. Pierce (a telecommunications expert) use the word that way. Frustrated by the confusion, Pierce says, "*information* is sometimes associated with the idea of *knowledge* through its popular use rather than with *uncertainty* and the resolution of uncertainty, as it is in communication theory."[127] However, Jaynes, Tribus, and, Cherry, successfully use the word in its popular sense – because they use *entropy to quantify information*. The same applies in the rest of this monograph.

Another view partially reconciles Shannon's definition with the popular usage in which information is "about" something in the real world – and also with the concept of Entropy. Information is, physically, an ordering of something in space and time in order to represent the ordering of something else that has objective reality. Spatial ordering is formation. It applies to both positioning and to application of effects. Concentration in space is massed effects. Temporal ordering is sequencing. Note that when information is

transmitted, it is normally temporally ordered – even if it represents the spatial ordering of something else. The rate of temporal ordering is its *tempo*. Coordinated temporal sequencing is *synchronization*. Concentration in time is simultaneity. Note that this is a physical definition including what the information is "about." However, the "meaning" of what it is about is still somewhat obscure, and this view does not adequately accommodate the *role* of information between individuals and organizations.

Now that the line is drawn between entropy as a quantity of information and the information itself, with information on the same side of the line as "knowledge" and "meaning," what *is* the meaning of "information?" What is the meaning of "meaning" for that matter? These questions have kept philosophers employed for a long time because they are so contentious. So they wont be completely resolved here. Dr. Colin Cherry says, "'Meaning' is a harlot among words; [she] is a temptress who can seduce the writer from the path of intellectual [fidelity]. There are many like her. Our language is filled with such words of easy virtue; ... their ambiguity is such that high sounding statements may easily be made, having little content."[128] If "meaning" is truly a word of easy virtue, then perhaps "data," "information," "knowledge," "message," "symbol," "sign," and "signal" are her illegitimate children. The intent of the outline above has been to give these waifs a happy and secure home, where they can also make themselves useful by doing their chores with consistency.

Cherry also offers some help thinking about what information *is*. "It may be helpful to refer to three levels of information, corresponding to the three levels of semiotic – the syntactic, semantic, and pragmatic levels."[129] The Shannon-type theories like that above are syntactic because they deal only with signs and the relationships

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between them. In the popular use, though, "information" is "about" something and it involves "users" – it is semantic and pragmatic. Semantic information is conveyed by sentences 'in the language,' not information for, or to, any particular person. And "pragmatic information concerns specific users and their responses to signs."[130]

THE ECONOMIC MODEL: INFORMATION AS A COMMODITY

One reason it is important to know *how much* information you have is calculating the transport capacity you need to distribute it. Thinking of information like this is akin to treating it as a commodity. Heinz Von Förster, considered by many to be a founding father in the field of cybernetics, identifies and describes the commodity model in his article "Epistemology of Communication," but he tries to refute it. He argues that this confuses "information" with the "signal" which represents it. It is the "signal" which is the commodity to Von Förster, whereas "communication is the glue which transforms a mere collection of individuals … into a 'society,' i.e. into a coherent whole"[131] However, Von Förster's criticism about "signal" vs. "information" may be excessive in a military context. Recall that the equation of the two terms is a legitimate definition, and that definition happens to be one of the ones supported by popular consent. Also, according to Webster's, "signal" is even more ambiguous than "information."[132]

The commodity model works quite well at describing the jobs of "information logisticians" in the Army, who by the way, call themselves "Signal" and "intelligence" soldiers. The model brings to mind associated images such as "information infrastructure" or its tactical equivalent, "information transport," "information pipelines," "information superhighway," "information warehousing," "information collection and distribution," and "information shelf-life." It describes a macroscopic

organization in which there is a system of information "production," "distribution," and "consumption." However, the metaphor is a qualitative description only, and it does not account for the *how* or the *why* information is produced or consumed.

The commodity model is extended backward through processing to discover data as a "raw material." Data must be extracted from the environment and processed to produce a useable material – like iron ore smelted to make steel. It also considers that the industries may not be located in the resource areas. Thus the requirement for an industrial distribution system (an information infrastructure). These intermediate materials are then available for the production of other intermediate items, like car doors and motors.

The metaphor is also extended forward. After the final stages of production, a consumable is produced. This is marketed and sold in accordance with a combination of established procedures and demand from consumers.

The economic model provides some good insights into what information *is*. Note, however, that this model does not adequately consider the role of information in organizations. The next model does this better.

MCLUHAN'S "HOT" AND "COOL" MEDIA

In *Understanding Media*, Marshall McLuhan characterizes various communications media and examines their effects on social organization. His basic mental model is that of the medium as an extension of man, and his thesis is a kind of technological determinism:

> In a culture like ours, long accustomed to splitting and dividing all things as a means of control, it is sometimes a bit of a shock to be reminded that, in operational and practical fact, the medium is the message. This is merely to say that the personal and social consequences of any medium – that is, of any extension of ourselves – result from the new scale that is introduced into our affairs by each extension of ourselves...[133]

His statement "the medium is the message" is more clear when he reinterprets it:

> the "content" of any medium is always another medium. The content of writing is speech, just as the written word is the content of print and print is the content of the telegraph... [and the content of speech] is an actual process of thought, which is in itself nonverbal.[134]

He describes two basic kinds of media: Hot and cool. A *hot medium* is one which extends a single sense in "high definition" (lots of data, like a photograph). A *cool medium* is one of low definition (little data, like a cartoon).[135] This concept is not as simple as it might seem. McLuhan says a telephone is a cool medium because the "ear is given a meager *amount* of information. And speech is a cool medium... because so much has to be filled in by the listener"[136] On the other hand, he says radio is a hot media because it does not require much listener "participation" – it can play in the background.

He traces the history of the development of communications. In this process his most consistent observation is the increases in the speed of transmission of information. However, high speed apparently does not equate to high definition. For example, while radio is a hot medium, he believes TV to be a cool one (but then again, he is writing in 1964).[137]

The speed of information apparently does influence the structure of societies, though. *Whenever the transmission rate speeds-up it promotes centralization* – "what some economists refer to as a center-margin structure" – because it is possible to execute controlling functions, at the same periodicity of action as before, but from a greater distance. However, if the speed-up is not uniformly available over the space to be controlled, then the "*lack of homogeneity in speed of information movement creates diversity of patterns in organization.*"[138]

Organizational stability also results from the predominance of cool media. On the other hand, an emergence of a hot medium as a predominant medium tends to promote

social change. It is important, again, not to confuse these with slow and fast media. The

defining criteria is *participation*. Describing the evolution of Greek society from villages

to city-states, McLuhan says, "There was first the village, which lacked ... group

extensions of the private physical body." There was some community and division of

labor and functions, though. Villagers were somewhat specialized. These conditions

promote the development of commerce and the beginning of transportation to execute it.

Thus begins communication, but thus also are communal conflicts intensified. Such

conflicts "send men huddling into even larger aggregates in order to resist the accelerated

activities of other communities. [The village had been a stable form.] Participation was

high, and organization was low. This is the formula for stability..."[139] However, the

growth of inter-village communications demanded even greater specialization... and

greater centralization.

In more modern times, McLuhan says, "man has extended his central nervous

system by electric technology, the field of battle has shifted to mental image-making-and

–breaking, both in war and in business."[140] His example is the deployment of wireless

telegraph technology. It enabled instant-speed information movement, and this produced

"a collapse of delegated authority and a dissolution of the pyramid and management

structures made familiar in the organizational chart."[141] This type of change promotes

further specialization.

The advent of the telephone, on the other hand, produced a decentralization. This

was because "the telephone demands complete participation unlike the written word on a

page."[142] Telephonic communication is neither particularly informative nor affective.

This means the listener must "participate" cognitively to a great extent in order to understand the communication.

Military command and control radios evolved first as radio-telephones. So one might be inclined to think of them as a "cool" medium like regular telephone. However, as long as the radio set is equipped with a speaker that is audible to the user, the user can "eavesdrop" on the transmissions of the other parties on the net. This eavesdropping capability requires less participation than conversation. In this mode the radio is a relatively "hot" medium. However, when the user becomes active in a conversation on the net, then the system is identical to the telephone. Then it is rather "cool."

McLuhan describes a speed-up provided by commercial radio (a hot media) that produced inhomogeneity in societies. Later, TV (a cool media) produced a centralizing effect that relieved radio of any centralizing influence and further enabled radio to cater to local special interest groups. "Radio... certainly contracts the world to village size... With TV accepting the central network burden derived from our centralized industrial organization, radio was free to diversify, and to begin a regional and local community service that it had not known."[143]

TV today is quite different from that in 1964, though. In fact it fits McLuhan's "high definition" criteria. Further, with the increased availability of specialized programming, TV is beginning to take on the character McLuhan attributes to the "hot" medium of radio. Whether for good or bad, TV should continue McLuhan's contraction of the global village. Perhaps he would argue that the highly participative nature of emerging network technologies (like the internet) will provide stability for the global village.

Video Tele-Conferencing (VTC) has recently emerged as an in-demand medium of command and control communications. It is certainly more "high definition" than telephonic communication. It conveys well the emotive messages of contextual and postural symbolism. However, the bandwidth required is proportional to the degree to which it speeds-up this kind of communication. One VTC session costs as much bandwidth as roughly a dozen simultaneous telephone conference calls. So there is at least for the near future, a natural check on the amount of centralization VTC can promote. Bandwidth, the data capacity of a communications channel, is costly. Often, it is also very challenging to provide in physical military environments. Dense foliage, extreme weather, and enemy action can all contribute to this challenge. Video Tele-Conferencing (VTC) is a hot medium; it also provides faster transmission of affective communication. However, because it is very expensive and not universally available, McLuhan would predict it would promote centralization where it is available and diverse decentralization where it is not.

The relevant questions are: Is this inhomogeneity in organization appropriate? Is the affective communications gain achieved with one VTC worth the loss of a dozen relatively non-affective telephone channels? Or is the VTC important enough to allocate lift assets to move the required equipment ahead of other important weapon systems? Will there ever be enough bandwidth? Or will always be a desire for more based on a desire for greater certainty? Will VTC cause rather than ease "information pathology" of Martin Van Creveld?[144] The answers to these questions are beyond the scope of this monograph, but they could be constructed using the framework provided here.

Binding and Adapting: "Information" in a Complex Societal Context

Information as a Social Glue

Heinz Von Förster says "communication is the glue which transforms a mere collection of individuals ... into a 'society,' i.e. into a coherent whole"[145] This metaphor is intuitively very appealing, and it is strongly supported by the anecdotal evidence of authors like S.L.A. Marshall, Anthony Kellett, and E. B. Sledge.[146] In the combat experiences that these men wrote about, there is a clear indication that small unit cohesion derives from informal (more affective than informative) communication within the primary group. But what is the range of that cohesion and what is the mechanism by which it arises from informal communication?

Colin Cherry devotes a whole section to "Communication and Social Pattern" in *On Human Communication*. He says that the idea of a "social" role of information arose in the nineteenth century when Herbert Spencer popularized the practice of referring to components of social structure by metaphor as parts of the human body.[147]

Herbert Spencer was the philosopher-hero of J.F.C. Fuller, the author to whom one can trace the origin of the US Army's principles of war in the early 1900's Field Service Regulations of the British Army. Fuller quotes Spencer eleven times in the space of four pages (197 – 200) of *The Foundations of the Science of War*, where Fuller develops his principles of war within the framework of a universal law of economy of force. On page 200, Fuller highlights the central theme of Spencer's *First Principles*, p. 285:

> "Spencer then shows that every change undergone by every sensible existence is a change towards integration or disintegration... '[changes in] everything and to the last [are] part of one of the two processes. While the general history of every aggregate is definable as a change from a diffused imperceptible state to a concentrated perceptible state; every detail of history is definable as part of either one change or the other. This

then must be the universal law of redistribution of matter and motion... The process thus everywhere in antagonism, and everywhere gaining now a temporary and now a more or less permanent triumph one over the other, we call Evolution and Dissolution. Evolution under its simplest and most general aspect is the integration of matter and concomitant dissipation of motion, while Dissolution is the absorption of motion and concomitant disintegration of matter.'"[148]

History credits Spencer with development of a "system of logical positivism ... setting forth the idea that evolution is the passage from the simple, indefinite, and incoherent to the complex, definite, and coherent."[149] As a result, he was labeled a Social Darwinist, but some of his ideas exhibit a uniformity that is appealing.

Cherry, however, is critical of Spencer, saying that Spencer's metaphorical references to societal components as systems and organs of the human body do not provide a basis for formulation (formal description) of a real testable model of society and its component subsystems.[150] They therefore lack informative value. Nonetheless, they appear to have the same sort of affective value that the commodity metaphors do. Unfortunately the only conclusion we can draw is that there is anecdotal support for an idea that the cohesive strength of any aggregate of individuals is dependent on the ready-availability of a form of communication that supports a bias for the exchange of affective messages. The more "personal" the communication the better.

THE TOPOLOGY OF MILITARY COMPLEXITY

Cherry uses a concept involving "social networks" and "social fields" to describe some interesting features of the behaviors of groups of individuals.[151] He mentions different group behaviors that result from the topology of interconnectedness. For example, social *organization* increases drastically when groups are bound together by telecommunications *networks* of large numbers of individual node to node links. On the other hand in crowds ("*fields*") where communication is not "canalized" by such links, "wave-like" patterns arise, like the "spread of a disease." Cherry also presents several

analogies representing the behaviors of these social structures. Examples include mechanical images like the "swing of the pendulum" about some kind of "equilibrium," or "government machinery," or "social forces." There are also biological analogies like "social organism" that undergoes "evolution."[152] Cherry is critical of such metaphors if they cannot explain the "influences" exerted on people. Thus he is expressing the common difficulty in describing the nature of *affective* communication.

Army units are not initially like crowds, but rather have formal structure and a "purpose" which is defined by a higher command authority. Therefore, they initially exhibit network rather than crowd type topology. That is until they "dis-integrate" in battle– then they become crowd like, as their social network is destroyed.[153] Further, a large tactical army unit fits his category of "purposeful, goal seeking organism" that can adapt its own rules about how its communication capability is used, (as well as its command and control relationships) to increase its efficiency or effectiveness in accomplishing its mission. With this description, an army unit is what M. Mitchell Waldrop calls a "self organizing complex adaptive system."[154]

Libicki also describes a new form of military organization in "The Small and the Many," which appears as a chapter of RAND's *In Athena's Camp: Preparing for Conflict in the Information Age.* In this article, Libicki assesses potential threats over the next several decades and proposes a solution to the Van Creveld "Information Pathology" likely to result from current trends in information-related military development. His solution is basically a highly networked system of cheap "cue and pinpoint" sensors and weapons – with highly distributed intelligence.[155] As such, his description resembles what Kevin Kelly calls a "hive" or "swarm" organization – biological metaphors for

highly distributed self-organizing, complex, adaptive systems.[156] The organization of

Libicki's system is what he calls a "mesh" and its operation is what he calls "fire ant

warfare."[157]

> Human command would also evolve. Information technology permits greater
> centralization—because better telecommunications increase the amount of data that can
> be sent to core. However, it also permits greater decentralization—because better
> computation allows units to handle more date from colleagues. Tomorrow's military
> systems will do both. Headquarters will be able to do more detailed unit control, but units
> will be able to undertake more functions in degraded communications environments.
> Meshes could be engineered to take humans out of many decision loops. Complete
> removal from the loop is possible. Yet, a technology which permits less human oversight
> need not compel it. The bogeyman of an automated war machine will be no greater than
> it is today.[158]

Libicki's system solves only the aspects of information pathology associated with

cybernetic coherence. It does not address those aspects associated with moral cohesion.

That is not Libicki's purpose. However, it is also possible to describe the role of

information in the moral domain using the notion of self-organizing, complex, adaptive

systems.

COMMUNICATION AS A CATALYST

Such organizations, in order to "evolve" or "adapt," need a catalyst of some kind,

and affective communication is such a catalyst. This complex model views the military

organizations (both unitary and compound) as distributed, interconnected, and dynamic.

With the help of affective communication, these characteristics enable new order to

emerge from changes imposed on the system through its interaction with its environment

and other actors in it. For Kellett the catalyst is information about the unit's purpose, and

its behavioral norms. Group membership becomes more important than life. James M.

McPherson expresses a similar idea in *For Cause and Comrades*, but in his view the

catalyst is information about the "cause" (that defines the group's identity) for which the

group fights.[159] Many of the elements of group cohesion identified by Kellett and

McPherson are evident in Eric Hoffer's *The True Believer*. While Hoffer's focus differs,

he most significantly notes: "The pattern seems to be that as one form of corporate

cohesion weakens, conditions become ripe for the rise of mass movement and the

eventual establishment of a new and more vigorous form of compact unity."[160]

Corrielli Barnett also implies a sort of catalytic effect in *The Swordbearers*.

Barnett assesses the World War I leadership of Colonel-General Helmuth von Moltke (the

younger), chief of the German General Staff:

> Amid the stark furniture and schoolroom smell of chalk dust of O.H.L., Moltke studied
> the reports, trying to form a true picture by **reason** and **intuition** out of "facts" that might
> or might not be correct, out of subordinates' judgements that might or might not be
> sound. The map of France, so long pored over in war games, did not show him a pattern
> of victory.[161]

Barnett is critical of the German model of centralized command from the rear and

contrasts it with the "lead from the front" style of other leaders. With German Armies

within a day's march of Paris, at the Marne river the decisive battle began. "Whereas

Joffre first asked his army commanders if their men were up to a counterstroke, Moltke

was utterly out of touch and feel with the moral and physical state of his troops."[162]

> A bellowed telephone conversation over a bad line was no substitute for direct contact of
> minds and personalities... There remained coded telegrams and radio signals, naturally
> kept as brief as possible. Moltke and his battle commanders were like deaf men with
> poor ear trumpets trying to carry out a complex technical discussion.[163]

The communications available to Moltke was not "informative" enough to

support his faculty of *reason*, nor was it "affective" enough to support his faculty of

intuition. Nor was it robust enough for him to "affect" and motivate his subordinates.

Barnett implies that Moltke's centralized command structure increased his organization's

vulnerability to ineffective, insufficiently informative, communication. Moltke and his

staff could not solve the problems that confronted the organization. They were a single

point of failure. To fix this, Barnett implies, Moltke should have "gone forward," as

Joffre did, "taking the pulse of his army by conferences with his army commanders on the spot, forming his own direct opinions of their morale and capacity, inspiring them with his own crude strength."[164] Note that this example indicates the *bidirectional nature of catalytic affective communication. Upward, it "takes the pulse;" downward, it motivates.*

ON BREVITY, UNCERTAINTY, AND INTUITION

In *general*, informative communication seeks brevity and efficiency, but as Casti explains, it is impossible to linguistically symbolize everything.[165] Therefore, word-substitution – such as with metaphor that has an affective as well as informative content – actually increases efficiency. It might even be said that some communication would be impossible without affective means. This also means that the "knowledge" resulting from the receiver's cognition is not completely determined. Different individuals are affected in different ways and reason/intuit differently. From one perspective this might add uncertainty to the decision making process. However, two factors counteract this uncertainty. First, the staff performs *collective* analytical planning as time allows. Second, there is only one commander (decision-maker), whose opinion "decides" or resolves the uncertainty. In this model, decision making is a process whereby the commander uses "informative" *and* "affective" communication to receive and send information from and to his staff, his subordinates, and other commanders. The commander fills "logic holes" by intuition, overcoming uncertainty. Then judgement synthesizes new understanding, and with this he formulates his updated purpose and intent. Still, the decision-making process does not stop there – the commander must still articulate this to his subordinates, his superiors, and lateral commanders. His mind may

be described as a critical node in the complex, adaptive, self-organizing system. Information representing the commander's updated purpose and intent is then communicated throughout the system. This catalyzes coherent planning and cohesive activity throughout the organization.

COMPLEXITY AND ADAPTIVITY IN MODERN BUSINESS MANAGEMENT

Modern business managers have recently taken great interest in the study of catalyzed evolution, complexity, and "adaptation." Anthony J N Judge, of the Union of International Associations, Brussels, Belgium, calls this "coping." In *Future Coping Strategies*, Judge describes many different solutions found in the literature. Several of the works Judge cites mention the importance of intuition, and many of them mention the catalytic role of communication. Further, in many of these works, metaphorical communication is the catalytic communication.[166] One of the authors he mentions is Edward de Bono, *Six Thinking Hats*, 1987 and *Six Action Shoes*, 1991. According to Judge, De Bono deals with "operacy" as he calls the "skill of action, of getting things done and making things happen."[167] Judge says,

> de Bono illustrates, for ... insights to be of significance to a wider audience, there is a need to capture understanding of each strategy in an appropriate **image** -- to bypass the often alienating impact of psychological and other jargons. Some of the earlier examples make extensive use of metaphor. This imagery then makes any repertoire or menu of coping strategies meaningful to individuals (or groups) ... Labeling strategies with technical terms does not engender enthusiasm for change -- it does not capture the imagination or initiate a dynamic.

Another author cited by Judge is Harvard educator Howard Gardner, who "has identified seven recognizable and different ways of processing information which he calls "multiple intelligences." They are:

> *Linguistic intelligence*: Ability to use language, auditory skills.
> *Logico-mathematical intelligence*: Ability to think logically, sequentially...
> *Spatial intelligence*: Ability to visualize and manipulate images mentally.
> *Musical intelligence*: Ability to hear, appreciate, and play music.
> *Bodily kinesthetic intelligence*: Physical ability,...-motor coordination.

Interpersonal intelligence: Ability to relate successfully to people.
Intrapersonal intelligence: Ability to be self-motivated or inner-directed."[168]

Incorporating these ideas into the developing model, one can understand that purely informative communication is neither sufficiently informative nor inspiring. Affective communication overcomes these deficiencies, but the meaning of information exchanged this way is still highly subjective.

PUTTING "INFORMATION" IN THE PROPER CONTEXT

The complexity model uses a notion that information derives its meaning from its context. Magoroh Maruyama calls this "contextual information." In "Information and Communication in Polyepistemological Systems," Maruyama contrasts this with the traditional western notion of information that he calls "classificational." The table below restates Maruyama's four categories of difference.[169]

	"Classificational Information"	*"Contextual Information"*
1	Universe consists of "objects" which have "identity" and "mutual exclusion" and can be classified into a hierarchy of categories	The universe is basically heterogeneous
2	Increasing categorical Specification, implies an increase in information "value"	The universe consists of interrelations and interactions and everything occurs in a context that may vary. Therefore the value of information lies in relation to its context (interrelations).
3	A "piece" of information has an "objective" meaning which is universally understandable without reference to other pieces of information	"Objective" meaning is useless; there is no universal meaning; each piece of information must be interpreted in the context of other pieces of information and in terms of the given situation.
4	Discrepancies within a message or between messages must be errors	Differences within a message or between messages convey information about the interrelations, just as in binocular vision, the differentials between two images enable the brain to compute an invisible third dimension

Maruyama also formulates a model for the characterization of four different categories of epistemology. Though there is no explicit reference to any common influence, these four categories correspond very closely to the four categories of types of system behavior identified by Waldrop in *Complexity*, and Casti in *Complexification*.

Selected portions of Maruyama's table are presented below; two rows are added to show

the connection to the categories of Waldrop and Casti, and the order is changed to reflect

the same order Waldrop uses.[170]

Magaroh Maruyama's categories of epistemology				
	Homogenistic	*Heterogenistic*		
	Hierarchical Classificational	*Reciprocally Causal*		*Isolationistic independent event*
		Homeostatic	*Morphogenic*	
Waldrop Category	Category I (Convergent Order)	Category II (Periodic Order)	Category IV (Complexity)	Category III (Chaos)
Casti Attractor	Classical Attractor: Fixed Point	Classical Attractor: Limit Cycle	Strange Attractor: Unstable orbit	Strange Attractor: Aperiodic Path
Philosophy	*Universalism*: Abstraction has higher reality than concrete things *Organismic*: The parts are subordinated to the whole	*Equilibrium or Cycle*: Elements interact in such a way as to maintain a pattern of heterogeneous elements, or they go in cycles	*Heterogenization, Symbiotization, and Evolution*: Symbiosis thanks to diversity. Generate new diversity and patterns of symbiosis.	*Nominalism*: Only the individual elements are real. Society is merely an aggregate of individuals.
Perception	Rank ordering, classifying and categorizing into neat scheme. Find Regularity.	Contextual: Look for meaning in context. Look for mutual balance, seek stability.	Contextual: Look for new interactions and new patterns. Things change and relations change. Therefore meanings change and new meanings arise.	Isolating. Each is unique and unrelated to others.
Knowledge	Belief in existence of one truth. If people are informed, they will agree. There is a "best" way for all persons. Objectivity exists independent of perceiver. Quantitative measurement is basic to knowledge.	Poly-ocular: binocular vision enables us to see three-dimensionally, because the differential between two images enables the brain to compute the invisible dimension. Cross-subjective analysis enables us to compute invisible dimensions. Diversity in perception enriches our understanding		Why bother to learn beyond my interrest?
Information	The more specified, the more information. Past and future inferable from present probabilistically or deterministically	Loss of information can be measured by means of redundancy or by means of feed-back devices.	Complex patterns can be generated by means of simple rules of interaction. The amount of information needed to describe the generated pattern may be greater than the amount of information needed to describe the rules of interaction. Thus amount of information can increase.	Information decays and gets lost. Blueprint must contain more information than the finished product. Embryo must contain more information than adult.

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The information theories above should serve to clarify the different perspectives one might have in thinking about "information." The "meaningless" model is syntactic, not pragmatic. It quantifies the ordering of things, but it does not describe them – it is not "about" them. The economic model provides good insight about what information *is* in a pragmatic and perhaps semantic sense. However, it does not fully address the *role* of information. The contextual social model provides this pragmatic functional aspect.

The next section develops a framework for identifying immutable concepts like the "Principles of War" and "Core Functions" found in various version of US Army doctrine. Later in this monograph, this framework is used to clarify the relationship between the Principles of War and the Core Functions – to include information related functions.

OTHER CONTEMPORARY THOUGHTS ON THE ROLE OF INFORMATION

COMBAT POWER = INFORMATION X (THE SPEED OF LIGHT)² – REALLY?

In "Information, Combat Power, and the Digital Battlefield," MAJ Arthur S. DeGroat, David C. Nilsen, and the Advanced Warfighting Working Group say:

> We posit that information and combat power are forms of the same thing. Information is combat power the same way that Einstein said that energy and matter are the same. [$E = mc^2$] Perhaps this is the logic underpinning CSA General Sullivan's statement that, "Information is the currency of victory on the battlefield."
>
> Combat Power = Information X (the speed of light)^2
>
> The equation above describes our metaphor in a conceptual manner, not in the mathematical sense. Information and combat power are two forms of the same asset, and can be used interchangeably on the battlefield, or more importantly in a complementary manner for optimal effectiveness. The means to take advantage of this equivalency is economy of force. The digital battlefield is all about economy of force. The efficiency and precision gained by digital situational awareness produces opportunities to mass the effects of combat power as never done before.[171]

This non-rigorous use of metaphor turns a good idea into pseudo-science. After the metaphor catches the attention, it begs deeper inspection. First, General Sullivan's

comment is more likely a reflection of his use of the *cybernetic commodity* mental model of the nature and role of information in military operations. Second, using the equation $C = Ic^2$ implies that this should be taken as a valid formulation of the concept – it literally says *information : combat power :: mass : energy* – but the authors then say that it should *not* be taken mathematically, but conceptually instead. That makes the mathematical expression of their metaphor an oxymoron. The mathematical expression *is* conceptual, but is incongruous with the concept they wish to present. Einstein's mass-energy equivalence is conceptually formulated by the equation $E = mc^2$. However, the DeGroat and Nilsen equation $C = Ic^2$ implies that, because it is a form of the same thing, combat power is *proportional* to information – which it implies that information is a quantifiable variable. It further implies that the more information you have, the more combat power you get. This is not at all what the authors intend. The fact that they must explain this in their subsequent text proves that their metaphor is a complete failure.

Their real message is that reducing uncertainty enables one to make better economy of force. They introduce a concept that associated with information is a certain amount of time after which acting on it cannot give one an advantage. They call this (TI) and they connect it to the time it takes to act (T). The concept they formulate is that as long as TI is greater than T, (or dTI = TI – T > 0) one can act on information to achieve an advantage.[172] This is a good idea, and it is also consistent with the other models presented in this monograph. However, it has nothing whatsoever to do with the $C = Ic^2$ metaphor.

Interestingly, notion of DeGroat and Nilsen that combat power and information are forms of the same thing is also a good idea, but in a way completely different from

what they articulate. Consider the idea that the instruments of national power are

essentially media for communicating policy. Notice that *military activity* and *information*

are indeed forms of the same thing. They are both such communications media.

However, that idea is not at all what DeGroat and Nilsen meant.

ENERGY = INFORMATION X (THE SPEED OF LIGHT)² – REALLY?

In "Black Lights: Chaos, Complexity, and the promise of Information Warfare,"

James J. Schneider describes a notion of information and communication that is

consistent with the models outlined in this monograph. He uses the different metaphors

at different points to describe the role of information in the moral and cybernetic

domains. He highlights the "revolutionary" changes in the nature of military

organizations with the advent of electronic signaling equipment in a manner similar to

McLuhan. His thesis is that with this new technology, armies were able to "liquify and

flow," performing an "operational art" that transformed into "distributed complex

operational organizations." [173] He builds an argument explaining *how* this difference

emerges using a description of information that, at first, looks similar to that of DeGroat

and Nilsen:

> In 1905 Albert Einstein postulated his famous relation between mass and energy: $E = mc^2$. We postulate here for the first time a similar relation between energy and information: $E = I_f c^2$. We begin with the seemingly trivial observation that no two objects can occupy the same space at the same time: a fundamental characteristic of *mass*. Similarly, no two bits of information (I_f) can occupy the same space at the same time; thus, information has the physical dimension of mass... The mathematical relationship, $E = I_f c^2$, suggests two fundamental and revolutionary implications for any rigorous theory of information warfare. First, that information, as a form of *mass*, flows. Second, the *speed* of the transmission of information marks a revolutionary break with all forms of regulation and control prior to the middle of the nineteenth century.[174]

However, unlike the apparently similar formulation of DeGroat and Nilsen, which

was oxymoronic, Schneider actually intends his as a rigorous exposition of physical

principle. He commits a couple of errors in linguistics and logic, but his results are

sound. His belief may not be *justifiable* in the way he claims, but it is true. The following paragraphs reconcile these problems.

First, Schneider's mental model includes "bits of information." Bits are not information; they are real physical things which can be configured at any given time in one of two logical states. A group of these physical things can then be *ordered*. The *ordering* of these physical things is the information. Once the ordering is set, however, the bits cannot be changed without changing the information. So it is natural to think of the bits as "of" the information.

Second, he claims that no two bits can occupy the same space at the same time. However, binary bits are not the only way to store information – binary logic is not the only form of physical ordering that is possible. Some techniques for storing information use physical systems with more than one possible state (an atomic electron energy state for example). Such a system with four possible states can store the equivalent amount of information as two bits. So, it is possible for two bits to occupy the same space. However, if one considers the basic storage system (like the electron) rather than the bit to be a "unit" of information capacity, then the statement becomes: A physical storage "unit" can manifest only one state at any time, and no two physical "units" can manifest the *same* state at the same time. This is the famous "Exclusion Principle" of the Nobel-Prize winning physicist Wofgang Pauli.[175] So, rephrased, Schneider's claim is valid.

The reason Schneider makes this claim is to demonstrate information – mass equivalence so that he can use Einstein's mass – energy equivalence to postulate information – energy equivalence. However, the fundamental "units" or "quanta" of capacity for information storage need not *have* mass. Photons, fundamental quanta of

light energy, for example, have no mass. But the light energy-state (color) of a laser is obviously a quantum of information. What this demonstrates is an information – energy equivalence *without* a requirement for information – mass equivalence.

The two physical principles above, exclusion principle and the quantum model of information capacity, are the basis for the theory discussed in appendix 1 called the Maximum Entropy Formalism. This formalism makes "information theory" a legitimate *physical* theory. "$E = I_f c^2$" does not represent this theory, however, and the information – energy equivalence is not like the mass – energy equivalence. The first says that information capacity is quantified by the *number* of possible energy states. The second says that the rest-energy of an object is quantified by the *amount* of mass. These are completely different principles. Information capacity is not a function of the amount of energy, it is a function of the number of possible energy states. An electron with four possible energy states has the same information capacity as a cannonball that can be in one of four boxes, but the electron has much less energy. Schneider's formalism is false.

On the other hand, in this monograph the maximum entropy formalism serves as part of the basic description of the nature of information. But it does nothing to explain the role of information in the cybernetic and moral domains – which is what Schneider uses the information – energy equivalence for. Schneider claims that "$E = I_f c^2$" shows that information *flows*, and that it flows at speeds close to the speed of light. Neither of these claims is obvious, and the equation has already been shown false, but there is merit to Schneider's idea. Given modern telecommunications equipment, both statements are true, but one need not call upon information – energy equivalence to prove them.

First, information *flows* whenever the *thing which is ordered to represent the ordering of something else* is in motion. When this thing is in motion, it can be a communications medium if it is received by someone. To the recipient, the medium may appear to be a static thing and the information to be the *temporal* ordering of the medium. In modern telecommunication systems, described in appendix 1, the moving thing is a steady-state electromagnetic carrier which travels at the speed of light. The process of ordering it is called modulation. And if the modulated carrier is incident upon a receiver, then the receiver can detect the modulation of the carrier and recover the information. So, again, Schneider's belief is true, but it cannot be justified by "$E = I_f c^2$."

There are other flaws in Schneider's physics, but in each case, his core argument rests not on the physics, but on the social arguments like those of Kelley, Waldrop, and McLuhan. These social arguments are supported by anecdote and by empirical observation, as their authors describe. Schneider's core arguments cohere to those same observations. His attempt to lend them further scientific support fails.

One of his intermediate conclusions is that armies should attack the "speed" of their enemy's information rather than the "amount" of it. His later conclusion is that the terminal effect of this action is "cybernetic paralysis."[176] Considering McLuhan's idea that increasing speed promotes centralization of organization, one might expect that decreased speed will have the opposite effect. Instead of increasing centralization, it will cause *decentralization* of organization – by necessity. One might also argue that this effect is the adaptive response of a complex, self-organizing, adaptive system. This is in fact the same conclusion that Schneider comes to. Cybernetically paralyzed opponents can be expected to reorganize *"at lower levels of command.*"[177]

WHAT IS "GOOD" INFORMATION?

Joint Pub 6-0: Doctrine for C4 Systems Support to Joint Operations defines

"seven criteria [that] help characterize information quality:"[178]

Accuracy – Information that conveys the true situation

Relevance – Information that applies to the mission, task, or situation at hand

Timeliness – Information that is available in time to make decisions

Usability – Information that is in common, easily understood format and displays

Completeness – All necessary information required by the decision maker

Brevity – Information that only has the level of detail required

Security – Information that has been afforded adequate protection where required

Joint Pub 6-0 also defines seven C4 principles:[179]

Interoperable – Interoperability is the condition achieved among C4 systems or items of C4 equipment when information or services can be exchanged directly and satisfactorily between them and their users. [This is supported by] *Commonality... Compatibility... Standardization...* [and] *Liaison* [especially in multi-lingual settings].

Flexible – Flexibility is required to meet changing situations and diversified operations with a minimum of disruption or delay.

Responsive – C4 systems must respond instantaneously to the warriors' demands for information. [This is provided by] *Reliability... Redundancy...* [and] *Timeliness.*

Mobile – Warriors at all levels must have C4 systems that are as mobile as the forces, elements, or organizations they support without degraded information quality or flow.

Disciplined – C4 systems and associated resources available to any JFC are limited and must be carefully used to best advantage. [This is supported by] *Control and Management...* [and] *Information Prioritization.*

Survivable – The degree of survivability for C4 systems supporting the function of C2 should be commensurate with the survival potential of the associated command centers and weapon systems. [This is supported by] *Security.*

Sustainable – C4 systems must provide continuous support during any type and length of joint operation. [This requires] Consolidation of functionally similar facilities... Integration of special purpose and dedicated networks... Careful planning... Efficient management... Maximum use of the DISN... Judicious use of commercial services.

Both of these lists support the typical doctrinal bent for purely rational decision

making – where the role of the C4 system is to eradicate uncertainty. *Joint Pub 6-0* says,

"The ultimate goal of C4 systems is to produce a picture of the battlespace that is accurate and meets the needs of warfighters. This goal is achieved by fusing, i.e., reducing information to the minimum essentials and putting it into a form that people can act on."[180] They fail to acknowledge the role of information and communication in the moral domain. In the moral domain it is *affective* communication that is required, and the quality of information in this type of communication is determined at least in part by its connection to *values*. The ability to share affective communication may not be required in all cases, but as commanders try to *lead* by providing purpose, direction and motivation from afar, it becomes more important. Affective communication is also required by anyone who wishes to *sense* and judge the moral condition ("take the pulse")of subordinates.

THE FOUNDATION OF IMMUTABLE PRINCIPLES

The "principles" of military operations are the embodiment of the most fundamental of the military's collectively justified beliefs. In this monograph, examining principles does two things. First, they are the basic mental models around which other concepts form to extend the understanding of the military environment. The principles, as they are articulated, communicate these fundamental concepts to military problem solvers. As interpreted, they become heuristics – "rule sets" to guide thinking in problem solving. Many commentators caution against the use of set principles. They view "principles" as prescriptions for action. However, the notion of "principles" developed below shows how they are not prescriptions for action at all, but rather guides for thinking. They tell one not what to *do*, but rather what to *consider*.

The second purpose for the examination of the development of principles is that it provides insight into a possible method for discovering principles regarding the use of information in the military environment. This method is used later in the monograph.

According to the last several versions of *FM 100-5*, the principles cannot be prioritized and they should not be interpreted separately. Instead, they should be considered as part of a "collective whole... As Major E.S. Johnston noted in 1934, 'They are very general guides, subject to application or exception according to circumstances.' Moreover, they do not always apply in the same way to every situation. As J.F.C. Fuller noted, 'Every change in conditions will demand a modification in the application of the principles...'"[181] J.F.C. Fuller is, in fact, the single most influential individual in the development of the principles that appear in US military doctrine today. The next section explains his thinking and the process by which he established his principles.

J.F.C. FULLER AND THE PRINCIPLES OF WAR

J.F.C. Fuller wrote *The Foundations of the Science of War* while he was a Colonel and chief instructor at the British staff college, Camberly, England. It was the culmination of his theoretical work, and it was the basis of the later and more technical work for which he is currently better known. Fuller wrote *The Foundations of the Science of War* in an inter-war period following his personal experience as an infantryman in the Boer Wars and as the GS01 of the Tank Corps in World War I. He believed that changing technology necessitated changing methods, but he felt his contemporaries did not understand the basic nature of war. Therefore they were neither capable of properly applying nor of properly adapting methods of warfighting. With *The Foundations of the Science of War*, he sought to educate them -- providing a universal

basis for the examination of contemporary issues and the projection of the future.

Drawing from the philosophical ultimacy of the relationships between the extremes of

duality, Fuller described warfighting with one law of Economy of Force -- Controlling

the exertion of, and resistance to, pressure in the mental, moral, and physical spheres.

His result was a set of nine general principles which became British doctrine in Field

Service Regulations.[182] Today American doctrine reflects many of the same principles,

but their origin and historical meaning are not apparent in the official manuals.[183]

As described below, Fuller's method and conclusions are not perfect. His

philosophical method is ingenious, but it is hard to understand, and in parts it is

inaccurate. His use of common, ill-defined vocabulary clouds his meaning, but as this

monograph and the author's earlier work indicate, this is not a problem unique to Fuller.

The fact that most military writers are considered "misinterpreted" is testament to the

subjective nature of meaning. Fuller compared himself, as a scientist, to Isaac Newton,

and Newton considered himself to be a "Natural Philosopher." Thus, it is no surprise to

see that Fuller's metaphysical introduction culminates in an expression of Newtonian

Mechanics. He claimed that the extremities of the prototypical duality were "inertia" and

"activity." Together with their relationship ("motion") the duality becomes a *tri-unity* or

"threefold order" describing the realm of Force.[184] No object can be purely inert or

purely active, but all objects are in some state of relative motion. Similarly, Man is

characterized by a body and soul related by mind. Hence his *physical, moral,* and *mental*

spheres of war. Today we call these the "physical, moral, and *cybernetic* domains of

war."[185] Moreover, human conflict involves the exertion of and resistance to force –

where the relationship is *"economy of force."* This is Fuller's central "law" of war. He expanded from this idea, describing all aspects of war with threefold order.

The imprecise definitions of Fuller's terminology make much of his work hard to follow. So does the way he inconsistently orders the relationships of his terms. In the figure below, some of Fuller's triunities are clarified through proper association with other terms. Note that in all of his triunities, there is a term that provides "inertia" or "stable base," a term that provides "activity" or "power of action," and a term that provides the relationship like "motion" or "cooperation." Where this is not true, the words are not a triunity – they are an *arbitrary* group of three aspects.

Examples of the threefold order of J.F.C. Fuller				
Realm (page)	*Extreme A*	*Relationship*	*Extreme B*	*Brendler's Criticism*
Physics (49)	Inertia	Motion	Activity	
Man (55)	Body	Mind	Soul	
Generalization of organization from Man (55)	Structure	Maintenance	Control	Why isn't control the relationship?
Generalization of organization from Man (56)	Stable Base	Linkage for Cooperation	Power of Action	
Reasoning (58)	Knowledge (facts, logic)	Faith	Belief (no facts, logic)	Fuller's definition of Faith and Belief seem backwards
National Power (61)	Ethics	Politics	Economics	
National Aims (67)	Security	Policy	Power	
War Causes (66)	Ethical	Military	Economic	
Military Power (92	Resisting Power	Economy of Force	Striking Power	
National Means (92)	Civil Side	Grand Strategy	Military Side	
Spheres of Action (63/210)	Physical	Mental	Moral	What order? Is physical or moral the "stable base"
Mental Elements (93/210)	Reason	Imagination	Will	
Moral Elements (114/210)	Courage	Moral	Fear	Order?
Physical Elements (144/210)	Protection	Mobility	Weapons	Order?
Effects of Conditions (175)	Assist	Transform	Resist	
Functions of the Instrument of War (78)	Resist Pressure	Control	Exert Pressure	
Use of instrument in the mental sphere (225)	Distribute	Direct	Concentrate	
Use of instrument in the moral sphere (225)	Endurance	Determination	Surprise	
Use of instrument in the physical sphere (225)	Security	Mobility	Offensive Action	

Fuller applied this technique to develop his scientific method for discovering

principles of war. He had three basic rules: First, know the limitations of the instrument

of war (and understand that Man is ultimately the basic instrument). Second, know the

conditions and how they affect the use of the instrument. Lastly, know how to expend

force profitably. His result (shown below) was nine general expressions (or principles) of

the law of Economy of Force. Note those with corresponding principles in *FM 100-5*

(1993) are shaded and the *FM 100-5* (1993) principle is given in parentheses:

Economy of Force (Economy of Force)			
	Resist Pressure	*Control*	*Exert Pressure*
Physical Sphere	Security (Security)	Mobility (Maneuver)	Offensive Action (Offensive)
Mental Sphere	Distribute	Direct (Unity of Command)	Concentrate (Mass)
Moral Sphere	Endurance	Determination	Surprise (Surprise)

FM 100-5 (1993) also recognizes "Simplicity" and "Objective." Fuller discusses

simplicity of organization and planning in *The Foundations of the Science of War*, and he

goes into great detail describing "object" as the mental goal that is related to the physical

"objective" by the plan. As such, Fuller's "Direct" accommodates "Objective" since it is

the mental function of coordination. On this foundation, Fuller built a method for

applying his Science of War. His result was remarkably similar to the current US Army

Deliberate Decision Making Process.[186]

APPENDIX 2 – COMMAND AND CONTROL AND DECISION THEORY

CONCEPTUAL MODELS OF COMMAND AND CONTROL

Every conceptual model of the *process* of command and control recognizes separate functions involving description of a *desired state*, the *direction of action* to achieve that state, the sensation, detection or *recognition of deviation* from the desired state or from action progressing toward it, and the *correction* of that deviation. This is a feedback "control loop," and systems designed to perform these functions which include other than human components, are called "cybernetic."

Actually, the term "cybernetic" is somewhat out of vogue. Norbert Wiener made term popular in a 1948 book for non-specialists about the "feasibility and philosophy of machines that learn."[187] In the 1960's it was a new label for a field of study "thought of as a brand new science – or at any rate as a recent amalgam of older sciences."[188] Though even then, experts acknowledged the origin of many of the field's fundamentals "as far back as the early part of the nineteenth century."[189] The term itself is a derivative of the Greek for "steersman" or pilot of a ship, and its prototypical application for Wiener was World War II vintage steering control servomechanisms. Hence the title of Wiener's book: *Cybernetics.*[190] However, the field has devolved into separate and disconnected areas today. This is largely due to three influences: (1) the lure and then failure of the field of Artificial Intelligence, (2) the relative lack of computing resources at the time, and (3) the lure of "second order" cybernetics – in which observers are part of the system observed.[191]

Despite the "death" of the term, its constituent fields of study are still healthy.

Feedback control in particular is used in uncountable applications from home thermostats

to automobile cruise control systems, to industrial production line operation. It is also

applied in a wide variety of military applications from missile trajectory control to

command and control. The figure below shows the relationship between the components

of a generalized feedback control system.[192]
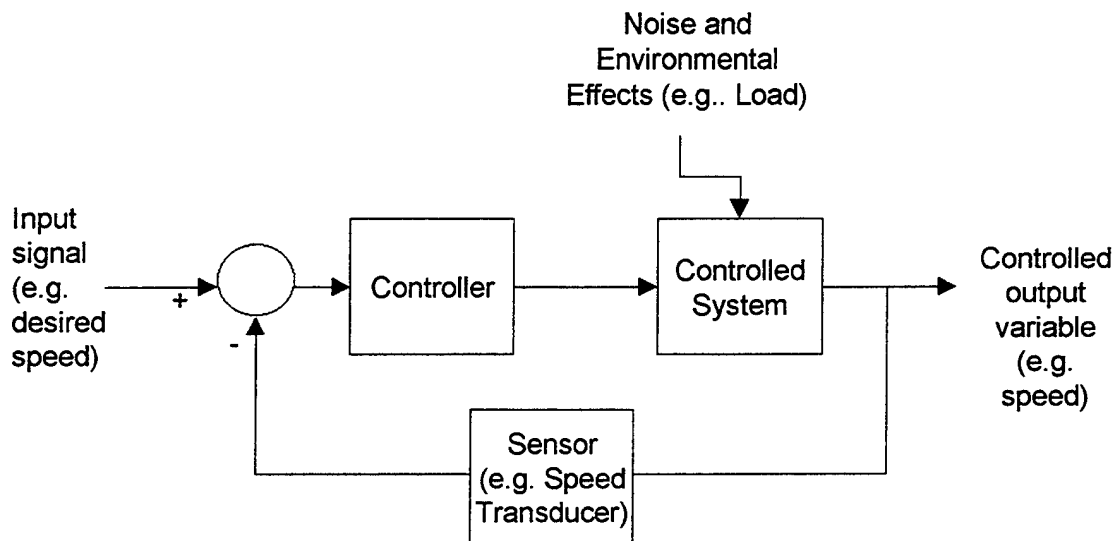
In *Command, Control, and the Common Defense*, Kenneth Allard of the National

Defense University examines C2 at the theater level. He describes three influential

conceptual models (from members of three different services). Allard uses these different

perspectives to develop insights about the "universal aspects of command in the

information age."[193]

Allard's first model is that of former Air Force Colonel John Boyd. "Boyd's

model," says Allard, "is the simplest and probably the best known."[194] It consists of what

Boyd considers to be the four basic steps of the C2 process: Observation, Orientation,

Decision, and Action –abbreviated OODA. Boyd considers each of the steps part of the

tactical decision loop. This model has become the conceptual foundation for decision-making in the modern maneuver warfare ideology. Its signature is the phrase, "turning inside the enemy's decision cycle." Boyd envisioned action against the enemy command system as a way to achieve this – an idea still prevalent in the writing of Air Force COL John Warden. Envisioning an enemy with similar intent, Boyd preached a command and control system that is:

> both ideological and conceptual, primarily resulting from a common mind-set between leaders and subordinates. This shared view, which is developed and reinforced by years of training, personal relationships, and common experiences, colors both perceptions of and reactions to combat situations. Rather than relying on a wealth of electronic communications, leaders control through the use of Auftragstaktik (literally, "mission-type orders").[195]

Both Boyd's model and the *Auftragstaktik* concept have received much comment. Allard claims that Boyd's description requires clarification and that the model former "Guru of Navy C3I," Dr. Joel S. Lawson, is better.

At the core of Lawson's model are the same four steps, though he calls them "Sense, Compare, Decide, Act." However, Lawson includes a notion of "Desired State" in the comparison. Thus his model can be layered, where action at one level is command input regarding the desired state to the next lower level. The diagram below illustrates both the Boyd and Lawson Models.[196]

S = Sense
P = Process
C = Compare
D = Decide
A = Act
DS = Desired State
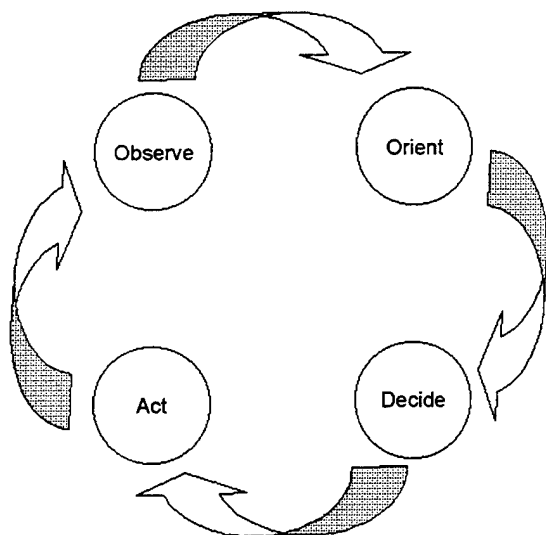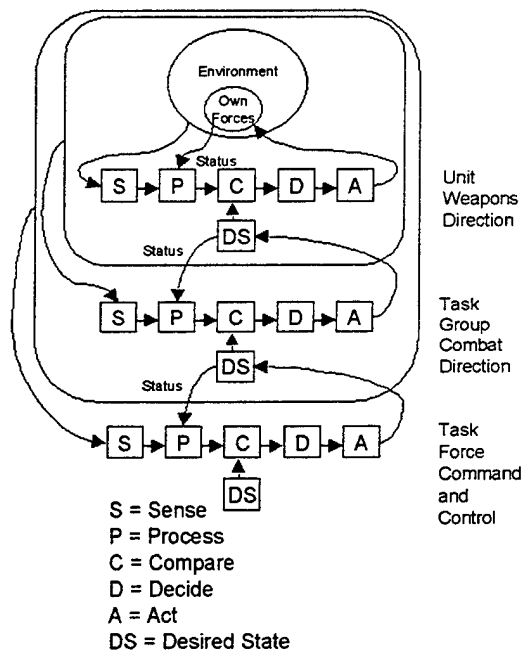
Boyd's OODA Loop   Lawson's C2 Model

Allard notes that Lawson recognizes that C3I is probably simpler for the Navy than for the other services. Allard says that the comments of retired Army General Paul Gorman reflect the same message. Allard presents a table for which he credits Gorman. A similar table follows:[197]

Three-Star HQ:	USN	USAF	USMC	USA
Moveable Subordinate Entities	$10^1 - 10^2$	$10^2 - 10^3$	$10^3 - 10^4$	$10^4 - 10^5$
Rank of Subordinate Leaders	Highest			Lowest
Communications With Subordinates	Best			Worst
Information About Subordinates	Precise			Vague
Tactical Flexibility	Greatest			Least
Command Principle	Centralize			Decentralize

More detailed discussion of these ideas on C2 is beyond the scope of this monograph. However, it is important to notice the role of information and communication in each of these models is consistent with the descriptions presented in the basic document.

CLASSICAL DECISION STRATEGIES

Ronald N. Giere provides a good summary of classical decision making in *Understanding Scientific Reasoning*. An expanded version of his summary diagram is below:[198]
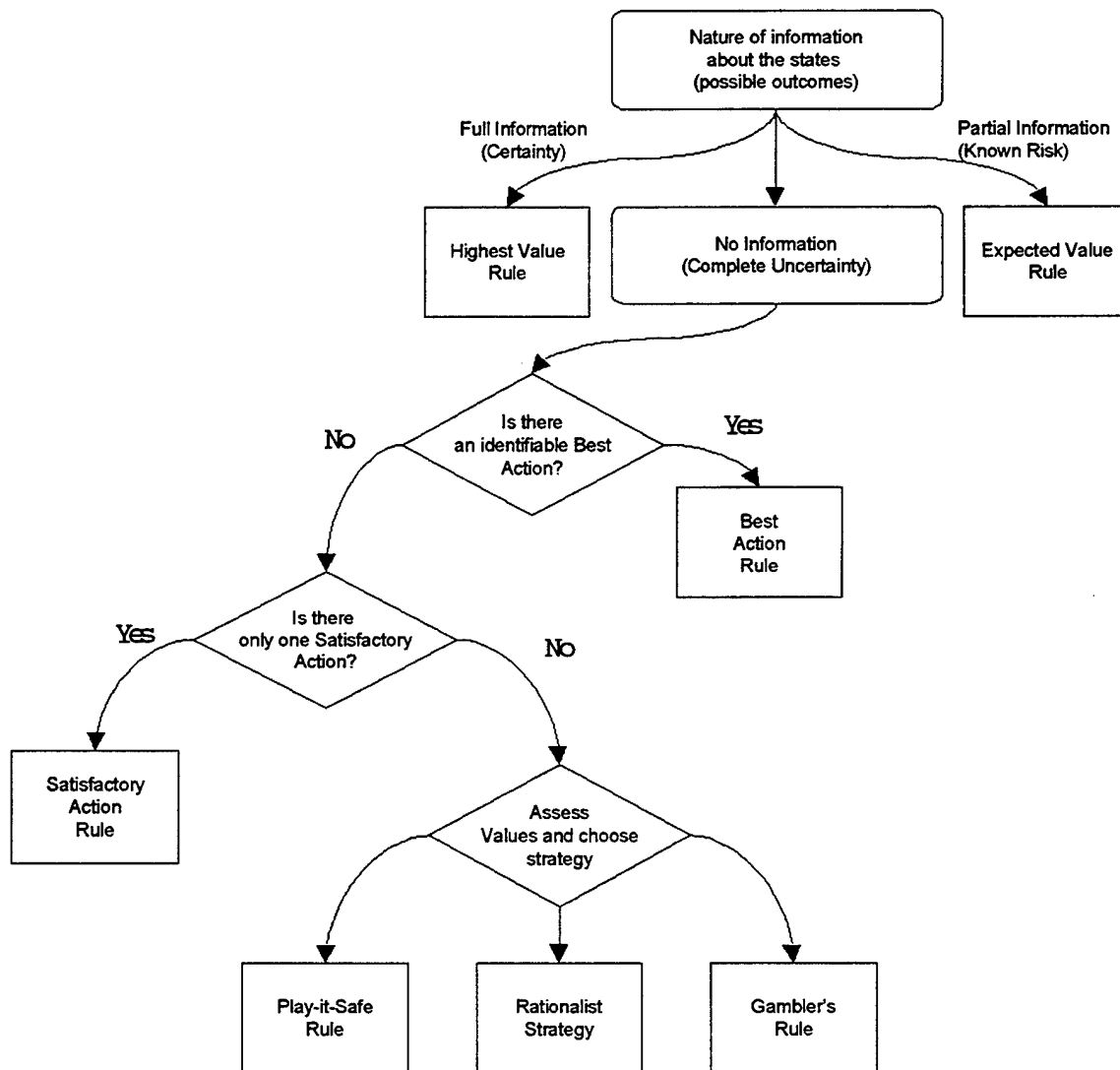
Giere's rule-set for this decision tree is shown in the table below. Note that the term "value" should be understood as a true value in the sense of the value systems associated with the affective domain. In this sense, "value" may be very difficult to quantify. "Value" may be much more complicated than something like "gain or loss in number of dollars."[199]

Highest Value Rule	Choose the action associated with the highest-valued outcome compatible with your knowledge of the states
Expected Value Rule	Choose the action with the greatest expected value (weighted sum of values of possible outcomes. Weights = probability of corresponding states)
Best Action Rules	If action A is the best action in the value matrix, do it.
	Action A is the best action if and only if it is better than every other action.
	Action A_1 is better than action A_2 if and only if there is at least one state for which A_1 has a higher valued outcome than A_2, and there are no states for which A_2 has a higher valued outcome than A_1.
Satisfactory Action Rules	If action A is the only satisfactory action in the value matrix, do it.
	Action A is a satisfactory action if and only if every outcome associated with action A has a value at least as great as the decision maker's satisfaction level for that problem.
	The satisfaction level of a decision maker is the minimum value that the decision maker regards as satisfactory.
Play-it-Safe Rule	Choose the action with the greatest security level
	The security level of any action is the value of the *lowest*-valued outcome associated with that action.
Gambler's Rule	Choose the action associated with the highest valued outcome
Rationalist Strategy	Choose the action whose outcomes have the greatest average value

APPENDIX 3 – EVALUATION CRITERIA DESCRIBED

FIDELITY – The metaphor should be rigorously derived and developed. It should also accurately and precisely represent the phenomenon. Fidelity is measured via the quality of the *formulation* and the rigorous *correctness*, *completeness,* and *correspondence* of the metaphor.

Formulation – Can an image or mathematical representation be extracted from the metaphor? (Yes is good.) In order to be of utility, the metaphor must provide a compact mental model of the "form" of the phenomenon. Most often, this is a description of the way in which objects within a system interact with each other and objects in other systems. Formulation is achieved by the use of literary or artistic image or mathematical representation. A metaphor that does not generate a mental model is a bad metaphor. A good metaphor generates a mental model of the dynamic nature of the system and its critical variables.

Correctness –Are the principles in the metaphor cited correctly and used appropriately? (Yes is good.) A metaphor based on incorrect principles is a bad metaphor because even in the best case it cannot evolve with improved understanding (or more complete expression) of the principles. In the worst case it misrepresents the phenomenon in all situations. Therefore, even if it succeeds in delivering its meaning, that meaning is cannot be the basis of a *justifiable true belief* – such a metaphor cannot deliver knowledge.

Completeness – Has the formulation been well developed? (More is better.) A good metaphor is complete enough to represent the phenomenon in all reasonable

circumstances. A metaphor based on an incomplete formulation is bad because it causes reductionism in thought and inconsistency in action. Dynamic systems cannot be completely represented by a static model. However, one should recognize that completeness might contend with simplicity.

Correspondence – Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.) In principle, correspondence means that the metaphorical model can be reduced to produce an agreement with other accepted models or other models can be reduced to produce an agreement with it. A good metaphor obeys this correspondence principle. A metaphor in doctrine that does not "correspond" is bad. Note that in *theory*, correspondence is not always a requirement, though it is desirable. Theory has the job of persuasion, and it is much easier to persuade others about a theory when it "corresponds" to their existing beliefs. Only accepted, corresponding theories should find a home in authoritative doctrine, however.

COMMONALITY – The metaphor should be common enough in its expression to serve reliably as a basis of common experience for the military lay-readership. The language used to explain the metaphor should be simple but unambiguous. Only this commonality in experience makes a metaphor produce the same meaning in its reader as is intended by its author. Commonality is measured with *reliability*, *simplicity* and *ambiguity*.

Reliability – Has the metaphor been used in the same way by many independent authors over a long period?[200] (More is better.) A reliable metaphor is one that has "stood the test of time." Note that there are three important factors in reliability. First and most important, the metaphor must be used in the same way. Many physical principles (such

as "mass") have become metaphors with a wide range of meanings. The second and third components of reliability are the number of authors and time. It is tempting to think that reliability could be quantified in cumulative author-years (the sum of the number of years all discovered instances have been published). However, this would falsely indicate that a sudden appearance of a metaphor in many authors' works means that its use will continue and carry the same meaning for a long time.[201] A better quantitative measure of reliability is years since its first occurrence.

Simplicity – What level of study is required to comprehend the metaphor? (Less is better). Note that simplicity is a characteristic of the *EXPRESSION* of the metaphor. It does not imply that the metaphor must represent a simple phenomenon. Many complex phenomena can be described by simple metaphorical expressions – making these metaphor amazingly efficient methods of translation. On the other hand, an overly complex metaphorical expression is bad because its lack of simplicity makes it incomprehensible to the layperson.

Ambiguity – Is the common experience attached to the metaphor single-valued? (Yes is good). The metaphor should unambiguously carry the same meaning to all its recipients. Ambiguity is avoided through intellectually rigorous use of language. Terms must be clearly defined, and more importantly, these definitions must be faithful to both the phenomenon and the common understanding. A good metaphor serves its purpose by clarifying and forming a basis for a common understanding. Metaphors described in imprecisely defined terms are bad. Also, metaphors described in terms that tend to have strongly different subjective meanings are bad whether or not they are precisely defined in the description.

APPENDIX 4 – EVALUATION OF THE METAPHORS

Metaphor: Information Superiority		
Criterion	**Measure of Criterion**	**Judgement**
Formulation	Can an image or mathematical representation be extracted from the metaphor? (Yes is good).	Yes. The notion of air superiority is visual enough – no threatening enemy aircraft or local command of the sea.
Correctness	Are the principles in the metaphor cited correctly and used appropriately? (Yes is good)	No. Only the informative nature of information is considered
Completeness	Has the formulation been well developed? (More is better)	No. The concept resembles broad-conceptual "hand waving"
Correspondence	Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.)	No. While it scales down to the physical level, it does not correspond to any model in which the affective nature of information plays a role.
Reliability	Has the metaphor been used in the same way by many independent authors over a long period? (More is better)	No. It is a new label. The concept, however, is as old as war.
Simplicity	What level of study is required to comprehend the metaphor? (Less is better)	Grade school. It's current use is actually simplistic and reductionist.
Ambiguity	Is the common experience attached to the metaphor single-valued? (Yes is good)	Yes. Doctrinal definitions are consistent.
Overall Judgement: *Information Superiority* is currently a bad metaphor. It considers only the informative nature of information, ignoring the affective nature. It also promotes inappropriate aggregation of functional proponents in an "IO cell." Further, it promotes a "bit count" mentality that distracts attention from the relevant questions themselves.		

Metaphor: Commodity		
Criterion	Measure of Criterion	Judgement
Formulation	Can an image or mathematical representation be extracted from the metaphor? (Yes is good).	Yes. The associated metaphors "Information Superhighway," "Information Infrastructure," "processing," "packaging," and "distribution" are very visual and part of every consumers common sense of the world.
Correctness	Are the principles in the metaphor cited correctly and used appropriately? (Yes is good)	Yes. Every component of the metaphor has a corresponding component in industrial society, and the associated facilities features function in the same way.
Completeness	Has the formulation been well developed? (More is better)	Yes. See the list of associated metaphors above.
Correspondence	Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.)	Yes. These metaphors are consistent with the physical principles. They are also typically used to explain the more complex metaphors.
Reliability	Has the metaphor been used in the same way by many independent authors over a long period? (More is better)	Yes, relatively speaking. These metaphors date back to the application of automatic control to industrial technology.
Simplicity	What level of study is required to comprehend the metaphor? (Less is better)	Grade school.
Ambiguity	Is the common experience attached to the metaphor single-valued? (Yes is good)	Yes. These metaphors are used consistently by all authors.
Overall Judgement: Cybernetic Commodity is a good metaphor by the evaluation of all these criteria. Perhaps its most useful feature is the good correspondence it enjoys with the newer, more complex metaphors. Thus it is a good tool for explaining them.		

Metaphor: Social Glue		
Criterion	Measure of Criterion	Judgement
Formulation	Can an image or mathematical representation be extracted from the metaphor? (Yes is good).	Yes. The image of the associated physical metaphor, cohesion, is clear, as is that of the loss of cohesion.
Correctness	Are the principles in the metaphor cited correctly and used appropriately? (Yes is good)	Yes. While the strength of the cohesive bonding described by the metaphor is hard to quantify, it is consistent with the notion that this strength depends on geometry (organization) and some kind of influencing "force" (affective communication).
Completeness	Has the formulation been well developed? (More is better)	No. It is not possible to extend the metaphor beyond the unquantifiable notion of affective communication as influence. This detracts from the metaphor's ability to convey the dynamic nature of organizational cohesion.
Correspondence	Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.)	Yes. The commodity models support the information transfer of the affective communication required for bonding.
Reliability	Has the metaphor been used in the same way by many independent authors over a long period? (More is better)	Yes. Von Förster's description is from the 1960s.
Simplicity	What level of study is required to comprehend the metaphor? (Less is better)	High school science.
Ambiguity	Is the common experience attached to the metaphor single-valued? (Yes is good)	Yes. The concept is single-valued as long as it is distinguished from coherence – in common action.
Overall Judgement: Social Glue is a good metaphor. It is somewhat abstract and cannot completely describe the nature and causes of moral bonding, but it corresponds well with other metaphors.		

Metaphor: Catalyst		
Criterion	**Measure of Criterion**	**Judgement**
Formulation	Can an image or mathematical representation be extracted from the metaphor? (Yes is good).	Yes. The action of catalysts in simple chemical reactions is fairly familiar
Correctness	Are the principles in the metaphor cited correctly and used appropriately? (Yes is good)	Yes. The metaphor relies only on the physical principles common to all accurate descriptions of the physical nature of information and communication.
Completeness	Has the formulation been well developed? (More is better)	No. The notion of catalytic action is only superficially explored. No subordinate associated metaphors extend the idea.
Correspondence	Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.)	Yes. It corresponds with the commodity model and the social glue model. In fact, it helps describe the dynamics that the social glue model cannot.
Reliability	Has the metaphor been used in the same way by many independent authors over a long period? (More is better)	No. This is a recent use.
Simplicity	What level of study is required to comprehend the metaphor? (Less is better)	High school is sufficient for the superficial description provided.
Ambiguity	Is the common experience attached to the metaphor single-valued? (Yes is good)	No. Direct experience with catalytic action is rare. This probably results in several different perspectives.
Overall Judgement: *Catalyst* is a pretty good metaphor. It is somewhat superficial, but it helps to describe the dynamic nature of organizations that the social glue metaphor cannot.		

Metaphor: Medium as Message		
Criterion	Measure of Criterion	Judgement
Formulation	Can an image or mathematical representation be extracted from the metaphor? (Yes is good).	Yes, the notion of telephone containing speech, containing language, containing thought … is easy to visualize.
Correctness	Are the principles in the metaphor cited correctly and used appropriately? (Yes is good)	Unknown. The principles cited are social phenomena which are difficult to rigorously verify.
Completeness	Has the formulation been well developed? (More is better)	Yes. McLuhan has written entire books on it and inspired many other authors as well.
Correspondence	Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.)	Yes. This corresponds well with the topological determinism described as a feature of information and communication as a *catalyst*, above. In fact, "metaphorical" correspondence is built into this philosophy as a basic principle.
Reliability	Has the metaphor been used in the same way by many independent authors over a long period? (More is better)	Yes, since McLuhan coined it in the 1960s
Simplicity	What level of study is required to comprehend the metaphor? (Less is better)	College. As a concept foreign to many people there is a significant challenge in dealing with the associated vocabulary.
Ambiguity	Is the common experience attached to the metaphor single-valued? (Yes is good)	Yes, but the concept is complex enough that deep investigation could probably lead to multiple perspectives
Overall Judgement: *Medium as Message* is a good metaphor (or perhaps even a physical principle). However, it is relatively abstract and complicated. It is not well known and understood. As a result, it may have utility unifying the ideas of academics or deep thinkers, but it is unlikely to be of direct utility for communicating with the average layperson.		

Metaphor: Core Functions		
Criterion	**Measure of Criterion**	**Judgement**
Formulation	Can an image or mathematical representation be extracted from the metaphor? (Yes is good).	Yes. Each of the core functions is represented by a common physical act. The formal formulation is demonstrated above.
Correctness	Are the principles in the metaphor cited correctly and used appropriately? (Yes is good)	Yes. They in fact derive from accepted "principles of military operations"
Completeness	Has the formulation been well developed? (More is better)	Yes. The revised formulation, uses McLuhan's notion of *medium as message* to correct the metaphorical deficiency of Fuller's original *economy of force* paradigm. Thus, the model becomes a composite of many metaphors which describe the actions performed by people and organizations as they use information and communication.
Correspondence	Does the formulated description correspond with a proper scaling of other generally accepted models? (Yes is good.)	Yes. This metaphor set is built on the *medium as message* metaphor, so it naturally corresponds to it. It also inherits the other correspondence to metaphors that *medium as message* enjoys. Further, the revised *core functions* set also enjoys a correspondence with both the core functions pertaining to other aspects of military operations and to the principles of war. They all have the same conceptual roots.
Reliability	Has the metaphor been used in the same way by many independent authors over a long period? (More is better)	Yes, Sun Tzu described functions associated with both "normal" and "extraordinary forces." Normal force functions include *engage, fix,* and *distract,* and extraordinary force functions include *win, flank/envelop, and decide*; other authors describing similar functions include Foch, Liddell Hart and Fuller.[202]
Simplicity	What level of study is required to comprehend the metaphor? (Less is better)	Grade school. Collectively, this is a complex concept, but the *core function* formulation articulates it in simple terms.
Ambiguity	Is the common experience attached to the metaphor single-valued? (Yes is good)	Yes. Each of the component metaphors are based on single-valued common experiences.
Overall Judgement: Core Functions is an excellent metaphor-set. It evaluates well with *all* of the criteria above. It corresponds well with each of the other metaphors described. However, it also uniquely adds a correspondence to other aspects of military operations and to the principles of military operations that other metaphors do not. Thus these *core functions* are the basis of a coherent system of thought which provides a uniform perspective from which to enable the reconciliation of apparent differences between the other models of the nature and role of information in military operations.		

ENDNOTES

1. Martin C. Libicki, *What is Information Warfare?*, (Washington, DC: National Defense University, USGPO, 1995), 3.

2. *Joint Pub 3-13, Joint Doctrine for Information Operations.* (Washington, DC: Joint Chiefs of Staff, 1998). (Preliminary Coordination), ix. "A fully functional IO cell is paramount to successful IO." See also Battle Command Training Program. "Information Operations: Achieving Information Dominance." Seminar Slide Presentation. (Fort Leavenworth, Kansas: USACGSOC, 1997). Especially slides 9, 10, 22 - 24.

3. Battle Command Training Program, "Information Operations: Achieving Information Dominance," Especially slides 2, 4, 12 – 19, 30.

4. Martin C. Libicki, *Defending Cyberspace and Other Metaphors*, (Washington, DC: National Defense University, USGPO, 1997), 108. Libicki's argument here supports his assertion in other parts of *Defending Cyberspace* that at the strategic level a separate "Information Corps" is not required. This author has extended that argument into the operational level with the assertion that the same rationale applies.

5. Libicki, *Defending Cyberspace and Other Metaphors*, 6 (emphasis added). Libicki in turn credits Mark Stefick's *Internet Dreams: Archetypes, Myths, and Metaphors* (Cambridge, MA: MIT Press, 1996) with the argument that the metaphors used to describe the Internet may be hazardous to its development.

6. Libicki, *Defending Cyberspace and Other Metaphors*, 6. Libicki says, "It is warfare because it resembles activities that surely are warfare."

7. Kahlil Gibran, *The Prophet*, 55th Reprinting of 1923 text, (New York, New York: Alfred A. Knopf, 1985).

8. *Webster's New Collegiate Dictionary*, (Springfield, Massachusetts: G. & C. Merriam Co., 1981), 716.

9. S. I. Hayakawa, *Language In Action.* (New York, New York: Harcourt, Brace and Company, 1941) 74 – 88 and 186 – 218. **Also.** *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation: "**af·fect** (e-fèkt¹) *verb, transitive* **... 1.** To have an influence on or effect a change in: *Inflation affects the buying power of the dollar.* **2.** To act on the emotions of; touch or move. **3.** To attack or infect, as a disease: *Rheumatic fever can affect the heart. noun* (àf¹èkt´) **1.** *Psychology.* **a.** A feeling or emotion as distinguished from cognition, thought, or action. **b.** A strong feeling having active consequences. **2.** *Obsolete.* A disposition, feeling, or tendency. [Latin *afficere, affect-* : *ad-*, ad- + *facere*, to do.] *Synonyms: affect, influence, impress, touch, move, strike.* These verbs are compared as they mean to produce a mental or emotional effect. To *affect* is to act upon a person's emotions: *The adverse criticism the book received didn't affect the author one way or another. Influence* implies a degree of control or sway over the thinking and actions, as well as the emotions, of another: *"Humanity is profoundly influenced by what you do"* (John Paul II). To *impress* is to produce a marked, deep, often enduring effect: *"The Tibetan landscape particularly impressed him"* (Doris Kerns Quinn). *Touch* usually means to arouse a tender response, such as love, gratitude, or compassion: *"The tributes* [to the two deceased musicians] *were fitting and touching"* (Daniel Cariaga). *Move* suggests profound emotional effect that sometimes leads to action or has a further consequence: *The account of her experiences as a refugee moved us to tears. Strike* implies keenness or force of mental response to a stimulus: *I was struck by the sudden change in his behavior. Usage Note:*

Affect[1] and *effect* have no senses in common. As a verb *affect[1]* is most commonly used in the sense of "to influence" (*how smoking affects health*). *Effect* means "to bring about or execute": *layoffs designed to effect savings*. Thus the sentence *These measures may affect savings* could imply that the measures may reduce savings that have already been realized, whereas *These measures may effect savings* implies that the measures will cause new savings to come about."

10. Massimo Piattelli-Palmarini,. *Inevitable Illusions: How Mistakes of Reason Rule our Minds*, Translated by Massimo Piattelli-Palmarini and Keith Botsford, (New York, New York: John Wiley and Sons) 1994) 32. Piattelli-Palmarini is a Principal Research Associate at the Massachusetts Institute of Technology and the Director of Cognitive Science at the Institute of San Raffaele in Milan, Italy.

11. Ronald N. Giere, *Understanding Scientific Reasoning*, (New York, New York: Holt, Rinehart and Winston, 1979), 305 – 337.

12. *Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C4) System Support to Joint Operations*, (Washington, DC: Joint Chiefs of Staff, 1995). In *Joint Electronic Library*, (Washington, DC: USGPO, 1997). I-4. **Also:** *Field Manual 100-5. Operations* (Final Draft). (Washington, D.C.: USGPO, 1997), 19-5.

13. Benjamin S. Bloom et al., *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain*, (New York, New York: Longman Inc., 1956), 7 and 201-207. **Also:** Benjamin S. Bloom et al., *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook II: Affective Domain*. (New York, New York: Longman Inc., 1964), 7 and 176 – 185.

14. Marshall McLuhan, *Understanding Media: The Extensions of Man*, (New York, New York: McGraw-Hill, 1964), passim, esp. 7, 8, 22, 90-91, 95-97, 103, 247, 267, 306-308, and 336.

15. Colin Cherry, *On Human Communication: a Review, a Survey, and a Criticism*. 2nd edition. (Cambridge, Massachusetts: The MIT Press 1966) 20 – 26, esp. 25.

16. M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Chaos*, (New York, New York: Touchstone, 1992), 294 – 299. Waldrop's primary protagonist is Brian Arthur of the Santa Fe Institute (SFI). Arthur and others at SFI describe all system behaviors with one of four labels. In two of these types the behavior of the system is completely determined. First is those behaviors which converge to a single value. Second is those behaviors which are periodic. The fourth is behaviors that diverge to random configurations. The third seems to be between the second and fourth: behaviors that produce a new (emergent) order.

17. Magoroh Maruyama, "Information and Communications in Poly-Epistemological Systems," in Kathleen Woodward, *The Myths of Information: Technology and Postindustrial Culture*, (Madison, Wisconsin: Coda Press, Inc., 1980), 29. Maruyama's paper is primarily an exposition of the cultural difference between the west, of which he is highly critical, and Asia, which he praises. Viewing his information in the context of the other papers in Woodward's book as he indicates one should, the paper supports the understated political message of the book that American society is bad. Nonetheless, the paper has some very appealing features.

18. J. F. C. Fuller, *The Foundations of the Science of War*. (London: Hutchinson & Co. 1925). Reprint, (Fort Leavenworth, Kansas: U.S. Army command and General Staff College Press) (page references are to the reprint edition), 225.

19. John L. Casti, *Complexification: Explaining a Paradoxical World Through the Science of Surprise*, (New York, New York: HarperCollins, 1994), 275. Casti quotes Yourcewar.

20. *Field Manual 100-5. Operations* (Final Draft, 1997), 19-4 – 19-12.

21. *Joint Pub 6-0*, does say that "combining information with context produces ideas or provides knowledge," I-3. *Field Manual 100-5. Operations* (Final Draft, 1997), says "situational awareness is inherently local and relevant to a particular echelon of the military force, digitization facilitates the sharing of situational awareness both vertically and horizontally.19-4.

22. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation. "**da·ta** (dâ′ te, dàt′ e, dä′ te) plural noun (used with a sing. or pl. verb) **1.** Factual information, especially information organized for analysis or used to reason or make decisions. **2.** Computer Science. Numerical or other information represented in a form suitable for processing by computer. **3.** Values derived from scientific experiments. **4.** Plural of datum." **In this model, definition #2 is most useful. Note however, that the suitability of data representation is a function of the *design* of the sensory or communication system.**

23. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation. "**proc·essed, proc·ess·ing, proc·ess·es 1.** To put through the steps of a prescribed procedure: *processing newly arrived immigrants; received the order, processed it, and dispatched the goods.* **2.** To prepare, treat, or convert by subjecting to a special process: *process ore to obtain minerals.* **3.** *Law.* **a.** To serve with a summons or writ. **b.** To institute legal proceedings against; prosecute. **4.** *Computer Science.* To perform operations on (data). **5.** To straighten (hair) by a chemical process; conk. *Adjective* **1.** Prepared or converted by a special process: *process cheese.* **2.** Made by or used in any of several photomechanical or photoengraving processes: *a process print.* [Middle English *proces*, from Old French, development, from Latin *processus*, from past participle of *procêdere*, to advance. See proceed.]"

24. According to Webster's: "**in·for·ma·tion** ... **1** : the communication or reception of knowledge or intelligence **2 a** : knowledge obtained from investigation, study, or instruction **b** : INTELLIGENCE, NEWS **c** : FACTS, DATA **d** : a signal or character (as in communication system or computer) representing data **e** : something (as a message, experimental data, or a picture) which justifies change in a construct (as a plan or theory) that represents physical or mental experience or another construct **f** : a quantitative measure of the content of information; *specif* : a numerical quantity that measures the uncertainty in the outcome of an experiment to be performed **3** : the act of informing against a person **4** : a formal accusation of a crime made by a prosecuting officer as distinguished from an indictment presented by a grand jury." 587. Also, MS Office Internet Dictionary: "**in·for·ma·tion** (ĭn′fer-mâ¹shen) noun Abbr. inf. **1.** Knowledge derived from study, experience, or instruction. **2.** Knowledge of a specific event or situation; intelligence. See synonyms at knowledge. **3.** A collection of facts or data: statistical information. **4.** The act of informing or the condition of being informed; communication of knowledge: Safety instructions are provided for the information of our passengers. **5** Computer Science. A nonaccidental signal or character used as an input to a computer or communications system. **6.** A numerical measure of the uncertainty of an experimental outcome. **7.** Law. A formal accusation of a crime made by a public officer rather than by grand jury indictment"

25. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation: "**cog·ni·tion** (kŏg-nĭsh¹en) *noun* **1.** The mental process or faculty of knowing, including aspects such as awareness, perception, reasoning, and judgment. **2.** That which comes to be known, as through perception, reasoning,

or intuition; knowledge. [Middle English *cognicioun*, from Latin *cognitio, cognition-*, from *cognitus*, past participle of *cognoscere*, to earn : *co-*, intensive pref.. See co- + *gnoscere*, to know]"

26. Massimo Piattelli-Palmarini,. *Inevitable Illusions: How Mistakes of Reason Rule our Minds*, Translated by Massimo Piattelli-Palmarini and Keith Botsford, (New York, New York: John Wiley and Sons) 1994) 32. Piattelli-Palmarini is a Principal Research Associate at the Massachusetts Institute of Technology and the Director of Cognitive Science at the Institute of San Raffaele in Milan, Italy.

27. James J. Schneider, "The Eye of Minerva: The Origins, Nature, and Purpose of Military Theory," *Theoretical Paper No. 5*, (Fort Leavenworth, Kansas: School of Advanced Military Studies, Command and General Staff College, 1995, 2nd edition), 11. The word "justified" is used because, epistemologically, the justification of belief is as important a component of knowledge as truth. *Whereas rules of inference for deductive argumentation require statements to be true in order to for a valid argument to be judged sound, this is not the case in inductive reasoning*. It was inductive reasoning which allowed man to progress beyond what Schneider calls the "Wall of Positivism" in *How War Works: The Origins, Nature, and Purpose of Military Theory*, (Fort Leavenworth, KS: SAMS, USACGSC, 1995), 6. Here Schneider uses "justified true belief" as the rationalist definition of knowledge, but here he relates that knowledge directly to theory whereas he relates it to science in "The Eye of Minerva." In the modern scientific method, it is inductive reasoning which allows man to complete the cycle with a testable hypothesis. Here, it is often not possible to show that an argument is deductively sound. Instead, the scientist argues inductively by persuading the reader that the statement or claim is **justified**. That justification is usually documented verification by experiment and coherence with other theoretical work. According to the 1982/83 lectures notes of Professors Shoemaker and Boyd of the Cornell University Department of Philosophy, there are **six basic definitions of knowledge** – each labeled by its own "ism": Empiricists claim that all our knowledge is derived from experience. *Phenomenalists* (a specific version of empiricists) say that an idea only has meaning (is knowledge) if it can be defined directly in terms of experience or possible experiences. *Foundationalists* claim knowledge is justified true belief – knowledge results when one's beliefs are either self-justified by immediate experience or via a "reliable" inference (either deduction or reliable induction). *Coherentists* are foundationalists who claim we are justified in belief that coheres with all our other beliefs. *Reliablists* are define knowledge as reliably produced, true, beliefs. Cornell Professors Shoemaker and Boyd taught Philosophy 101 *Classical Philosophy*, and Philosophy 131 *Logic: Evidence and Argument*, respectively. Their main references (the critical analysis of which was the basis for the course notes cited above) were Hume, *An Enquiry Concerning Human Understanding*, ed . Hackett, Giere, *Understanding Scientific Reasoning*, and Hocutt, *The Elements of Logical Analysis and Inference*.

28. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation. "**knowl·edge** (nŏl′ ĭj) *noun* **1.** The state or fact of knowing. **2.** Familiarity, awareness, or understanding gained through experience or study. **3.** The sum or range of what has been perceived, discovered, or learned. **4.** Learning; erudition: *teachers of great knowledge.* **5.** Specific information about something. **6.** Carnal knowledge. [Middle English *knowlech* : *knowen*, to know. See know + *-leche*, n. suff.. Synonyms: knowledge, information, learning, erudition, lore, scholarship. These nouns refer to what is known, as by having been acquired through study or experience. Knowledge is the broadest; it includes facts and ideas, understanding, and the totality of what is known: "A knowledge of Greek thought and life, and of the arts in which the Greeks expressed their thought and sentiment, is essential to high culture" (Charles Eliot Norton). "Science is organized knowledge" (Herbert Spencer). Information is usually construed as being narrower in scope than knowledge; it often implies a collection of facts and data: "Obviously, a man's judgment cannot be better than the information on which he has based it" (Arthur Hays Sulzberger). Learning usually refers to knowledge that is gained by schooling and study: "Learning is not attained by chance, it must be sought for with ardor and attended to with diligence" (Abigail Adams). Erudition implies profound knowledge, often in a specialized area: "Some have criticized his poetry as elitist, unnecessarily

impervious to readers who do not share his erudition" (Elizabeth Kastor). Lore is usually applied to knowledge about a particular subject that is gained through tradition or anecdote: Early peoples passed on plant and animal lore through legend. Scholarship is the knowledge of a scholar whose mastery of a particular area of learning is reflected in the scope, thoroughness, and quality of his or her work: a book that gives ample evidence of the author's scholarship

29. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation. "**judg·ment** also **judge·ment** (jŭj′ ment) *noun* **1.** The act or process of judging; the formation of an opinion after consideration or deliberation. **2. a.** The mental ability to perceive and distinguish relationships; discernment: *Fatigue may affect a pilot's judgment of distances.* **b.** The capacity to form an opinion by distinguishing and evaluating: *His judgment of fine music is impeccable.* **c.** The capacity to assess situations or circumstances and draw sound conclusions; good sense: *She showed good judgment in saving her money.* See synonyms at reason. **3.** An opinion or estimate formed after consideration or deliberation, especially a formal or authoritative decision: *awaited the judgment of the umpire.* **4.** *Law.* **a.** A determination of a court of law; a judicial decision. **b.** A court act creating or affirming an obligation, such as a debt. **c.** A writ in witness of such an act. **5.** An assertion of something believed. **6.** A misfortune believed to be sent by God as punishment for sin. **7. Judgment.** In traditional Christian eschatology, God's determination of which human beings shall be sent to heaven and which condemned to hell. [Middle English *jugement*, from Old French, from *jugier*, to judge, from Latin *iūdicāre*. See judge]."

30. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation. "**un·der·stood** (-st·d′) **un·der·stand·ing, un·der·stands** *verb, transitive* **1.** To perceive and comprehend the nature and significance of; grasp. See synonyms at apprehend. **2.** To know thoroughly by close contact or long experience with: *That teacher understands children.* **3. a.** To grasp or comprehend the meaning intended or expressed by (another): *They have trouble with English, but I can understand them.* **b.** To comprehend the language, sounds, form, or symbols of. **4.** To know and be tolerant or sympathetic toward: *I can understand your point of view even though I disagree with it.* **5.** To learn indirectly, as by hearsay: *I understand his departure was unexpected.* **6.** To infer: *Am I to understand you are staying the night?* **7.** To accept (something) as an agreed fact: *It is understood that the fee will be 50 dollars.* **8.** To supply or add (words or a meaning, for example) mentally. *verb, intransitive* **1. a.** To have understanding, knowledge, or comprehension. **b.** To have sympathy or tolerance. **2.** To learn something indirectly or secondhand; gather. [Middle English *understanden*, from Old English *understandan* : *under-*, under- + *standan*, to stand.]"

31. *FM 100-5 (1997 Final Draft)*, II-3-1. Emphasis added.

32. *FM 100-5 (1998 Revised Final Draft)*, per telephone conversation with LTC Charmichael, FM 100-5 writing team member.

33. Martin Van Creveld, *Command in War*, (Cambridge, Massachusetts: Harvard University Press, 1985), 1.

34. Van Creveld, 1-16.

35. *Field Manual 101-5*, 1-1.

36. *Field Manual 101-5*, 1-1.

37. *Field Manual 100-5 (Final Draft, 1997)*, 8-6.

38. Senge, 147. Senge develops the idea of a creative tension between the personal vision and the current reality. This is a source of personal motivation.

39. *Field Manual 101-5*, 1-3, US Army doctrine has a more simplistic view: "Staffs assist the commander with his battlefield visualization by collecting, processing, analyzing, and transforming data into knowledge, allowing the commander to apply his judgement to achieve understanding of the situation in the form of his vision." [A side note of criticism here: US Army doctrine equates a understanding the situation with the vision – this implies that figuring out how to make the transition – the problem solving process and the development of the commander's intent – is trivial.]

40. *The American Heritage® Dictionary of the English Language*, "**ge·stalt** ... (ge-shtält′ , -shtôlt′ , -stält′ , -stôlt′) *noun* ... A physical, biological, psychological, or symbolic configuration or pattern of elements so unified as a whole that its properties cannot be derived from a simple summation of its parts."

41. Joseph F. Bouchard, *Command in Crisis: Four Case Studies*, (New York, New York: Columbia University Press, 1991).

42. *Joint Pub 3-13.1, Joint Doctrine for Command and Control Warfare (C2W)*. (Washington, DC: Joint Chiefs of Staff, 1996). (In *Joint Electronic Library*, Washington, DC: USGPO, 1997). II-1. See also *Joint Pub 3-13, Joint Doctrine for Information Operations*. (Washington, DC: Joint Chiefs of Staff, 1998). (Preliminary Coordination), II-4; *Information Operations Primer*, (Fort Leavenworth, Kansas: USACGSOC, CADD, 1997), passim, especially 4-2; and Battle Command Training Program. "Information Operations: Achieving Information Dominance." Seminar Slide Presentation. (Fort Leavenworth, Kansas: USACGSOC, 1997), passim.

43. *Joint Pub 3-13, Joint Doctrine for Information Operations*. (Washington, DC: Joint Chiefs of Staff, 1998). (Preliminary Coordination), ix. "A fully functional IO cell is paramount to successful IO." See also Battle Command Training Program. "Information Operations: Achieving Information Dominance." Seminar Slide Presentation. (Fort Leavenworth, Kansas: USACGSOC, 1997).

44. Libicki, *What is Information Warfare?* x – xi. (emphasis added).

45. *Joint Pub 3-0, Doctrine for Joint Operations*, (Washington, DC: Joint Chiefs of Staff, 1995). In *Joint Electronic Library*, (Washington, DC: USGPO, 1997), II-16. *According to JP 3-0* "Command and control (C2) is the exercise of authority and direction by a properly designated commander over assigned and attached forces in the accomplishment of a mission... Command at all levels is the art of motivating and directing people and organizations into action to accomplish missions. Command requires visualizing the current state of friendly and enemy forces, then the future state of those forces that must exist to accomplish the mission, then formulating concepts of operations to achieve that state. Control is inherent in command. To control is to regulate forces and functions to execute the commander's intent. Ultimately, it provides commanders a means to measure, report, and correct performance." *Also see FM 101-5:* p. 1-1. "The focus of command and control is the commander. Command is the authoritative act of making decisions and ordering action; control is the act of monitoring and influencing this action. While command and control may be discussed separately for understanding, in practice, command and control is a unified entity. The commander cannot command effectively without control, and he, with or without the staff, cannot exercise control without command... Command is the art of decision making and of leading and motivating soldiers and their organizations into action ... The essence of command is defined by the commander's competence, intuition, judgment, initiative, and character, and his ability to inspire and gain the trust of his unit... Control is the promulgation of the commander's decisions, guidance, and intent with subsequent supervision and adjustment of subordinate forces' execution to ensure compliance with the commander's intent. Control may take place before, during, and after operations. Control may be exercised

directly or indirectly by directive, plan, or procedure. Information and time are critical to control. The commander, with the help of his staff, uses control to regulate forces and functions of subordinate and supporting units in military operations to ensure mission accomplishment. Control is based on situational information, such as mission, enemy, terrain, troops, and time available (METT-T), from all sources. the commander exercise control."

46. *Senior-Level Leadership and the Art of Command*, C710 Advance Sheet Booklet, (Fort Leavenworth, Kansas: USACGSOC, LID, 1997), 7 and 145. Note also that the doctrinal basis for the C710 course is *FM 22-103: Leadership and Command at Senior Levels*, June 1987. The course text rather than the manual is cited here because it is a better reflection of the current views of military leadership.

47. *Field Manual 22-100: Military Leadership.* (Washington, D.C.: USGPO, 1990), 1.

48. *Joint Pub 3-0*, II-16.

49. John P. Kotter, "What Leaders Really Do," In *Military Leadership: In Pursuit of Excellence.* Edited by Robert L. Taylor and William E. Rosenbach. (Boulder, Colorado: Westview Press, 1992), 21. Kotter's essay originally appeared in the May – June 1990 issue of *Harvard Business Review.*

50. Kotter, 22.

51. Kotter, 22.

52. Kotter, 22 – 25.

53. Kotter, 25 – 26.

54. Kotter, 27.

55. Anthony Kellett, *Combat Motivation: The Behavior of Soldiers In Battle*, (Boston, Massachusetts: Kluwer Boston, Inc., 1982) 46.

56. It is this constant phase relationship (coherence) which is responsible for the "interference pattern" of bright and dark bands which appears down-range from the grating.

57. *The American Heritage® Dictionary of the English Language*: "**phase** (fāz) *noun. Abbr.* **ph.** …. **5.** *Physics.* **a.** A particular stage in a periodic process or phenomenon. **b.** The fraction of a complete cycle elapsed as measured from a specified reference point and often expressed as an angle. **6.** *Chemistry.* **a.** Any of the forms or states, solid, liquid, gas, or plasma, in which matter can exist, depending on temperature and pressure. **b.** A discrete homogeneous part of a material system that is mechanically separable from the rest, as is ice from water." It is the *chemistry* definition that applies to cohesion and the concept of *phase transition.* However, the Physics definition is relevant to the meaning of coherence. This is the *phase* that must be constant in coherent light.

58. James J. Schneider, "The Theory of Operational Art," *Theoretical Paper No. 3.* Second Revision (Draft), (Fort Leavenworth, Kansas: School of Advanced Military Studies, Command and General Staff College, 1988), 3.

59. Joseph A. Brendler, *Physical Metaphor in Military Theory and Doctrine: Force, Friction, or Folly?* Student Monograph, (Fort Leavenworth, Kansas: USACGSOC, SAMS, 1997). (See Gavin's quote in Bacevich, as well as those of other authors in APPENDIX C of *Physical Metaphor*)

60. Raymond A. Serway, *Principles of Physics*. (Fort Worth, Texas: Saunders College Publishing, Harcourt Brace, 1994), 385.

61. Arthur L. Ruoff, *Introduction to Materials Science*, (Huntington, New York: Robert E. Krieger Publishing Co., 1979), 265.

62. Ruoff, 210 – 212.

63. Kellett, 153.

64. Kellett, 49 - 51.

65. S.L.A. Marshall, *Men Against Fire: The Problem of Battle Command in Future War*, (Glouster, Massachusetts: Peter Smith, 1978) 124.

66. Marshall, 126, 133, and 197.

67. Marshall, 127.

68. Marshall, 129.

69. Marshall, 92, 93.

70. McPherson, Factors in bonding by page: Honor – 77; Unit Pride and loyalty vs primary group cohesion – 84,89; .Information from home – 133; Propaganda – 145; Revenge – 149; Religion – 62; Courage – 163.

71. Major Robert Crisp, *Brazen Chariots: An Account of Tank Warfare in the Western Desert, November – December 1941*. (New York, New York: Bantam Books. 2nd printing. 1978.Reprinted by USACGSC, Fort Leavenworth, KS, 1997), 123.

72. Crisp, 124 – 135.

73. *Field Manual 100-6: Information Operations*, (Washington, D.C.: USGPO, 1996), 2-13. Emphasis added.

74. *Field Manual 100-6*, 2-13.

75. Martin Van Creveld, *Command in War*, (Cambridge, Massachusetts: Harvard University Press, 1985), 258 – 260.

76. David M. Link, *Information Dominance*, CADD White Paper, (Fort Leavenworth, Kansas: CADD, USACGSC, 1995), 1.

77. Sir Julian Stafford Corbett. *Some Principles of Maritime Strategy*. (Annapolis, Maryland: U.S. Naval Institute, 1988), passim.

78. Glenn Buchan, "Information War and the Air Force: Wave of the Future? Current Fad?" RAND publication IP149, *Project Air Force*. http://www.rand.org/publications/IP/IP149/. (Santa Monica, California: RAND, March, 1996), 4.

79. Buchan, 4.

80. Buchan, 4, 5. Note: Buchan also acknowledges Libicki as an influence in this thought.

81. Casti, 12. Casti defines four criteria that a scientific hypothesis must meet before it can be considered a "rule." He says it must be *explicit, objective, public,* and *reliable.* Our hypothesis is explicit if it is unambiguously stated. It is objective if it is free of investigator bias. It is public if it is testable by anyone. Finally, if our hypothesis is repeatedly validated by many independent efforts – over a long period, we say it is reliable. It has stood the test of time, and we are justified in believing it as a "rule" or an element of our body of knowledge about the world. The criteria this monograph uses are designed to measure not only the justifiability of the metaphor, but also its general utility. In this monograph *public* and *objective* are incorporated by *commonality, explicit* by *ambiguity,* and *reliability* by itself. The other criteria used in this monograph serve to measure utility.

82. *Field Manual 100-5, Operations.* (Washington, D.C.: USGPO, 1993), v.

83. John L. Romjue, *From Active Defense to AirLand Battle: The Development of Army Doctrine 1973 – 1982,* (Fort Monroe, Virginia: US Army Training and Doctrine Command, Historical Office, June 1984), 50.

84. *Webster's New Collegiate Dictionary,* (Springfield, Massachusetts: G. & C. Merriam Co., 1981), 716.

85. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation.

86. Benjamin S. Bloom, et al., *Taxonomy of Educational Objectives: The Classification of Educational Goals,* Handbook I: Cognitive Domain, (New York, New York: Longman Inc., 1956, 7. In the cognitive domain, Bloom classifies educational objectives as follows: knowledge, comprehension, application, analysis, synthesis, and evaluation. Also Handbook II: Affective Domain, (1964), 6-7. In the cognitive domain, Bloom classifies educational objectives as follows: receiving (attending), responding, valuing, organization, and characterization by value or value complex. The objective of education – learning – is a necessary component of adaptive living. It has long been viewed as a task for the individual. More recently it has been described as a necessary component in the development of "shared meaning." (See Senge et al.) In both models, communication and individual learning are required before purposive action can take place. This makes the *Taxonomy of Educational Objectives* pertinent in military problem solving as a way of classifying the level of effect of information and communication in both cognitive and affective domains.

87. Donn A. Starry "Commander's Notes, no. 3" in John L. Romjue, *From Active Defense to AirLand Battle: The Development of Army Doctrine 1973 – 1982.* (Fort Monroe, Virginia: US Army Training and Doctrine Command, Historical Office, June 1984), 87.

88. Jacques Barzun and Henry F. Graff. *The Modern Researcher,* 4th ed. (Orlando, Florida: Harcourt Brace Jovanovich, 1977), 304.

89. Barzun and Graff., 304. Barzun and Graff note that the use of literary imagery is a tribute to poetry, but that the "residue in the reader's mind is jargon." However, they clarify that "jargon" originally was not derogatory. It simply meant "the special tongue of a trade or art – what we now call technical terms – those of music or carpentry or sailing. Such terms are indispensable, there being usually no others to mean the same things." Then they distinguish a form they say should be called "pseudo-jargon." These terms "purport to be special and indispensable even though they are not technical words. They are

pretentious imitations of technicality... they are not definite and fixed in meaning, and they can readily be dispensed with."

90. S. I. Hayakawa, *Language In Action*. (New York, New York: Harcourt, Brace and Company, 1941) 74 – 88 and 186 – 218. Also, on p. 30 Hayakawa says, "human beings... can make anything stand for anything [having agreed how to communicate verbally]. We shall call that system of agreements *language*."

91. Hayakawa, 192 – 197. Hayakawa continues: "Metaphors are not 'ornaments of discourse'; they are direct expressions of feeling and are bound to occur wherever we have strong feelings to express. They are to be found in special abundance, therefore, in all primitive speech, in folk speech, in the speech of the unlearned, in the speech of children, and in the professional argot of the theater, of gangsters and other lively occupations... No implication is intended, however, that because metaphors ... are based ultimately upon primitive habits of thought they are to be avoided. On the contrary, they *are among the most useful communicative devices we have*, because by their quick affective power they often make unnecessary the inventing of new words for new things or new feelings. ... Metaphors, that is to say, are so useful that they often pass into the language as part of its regular vocabulary. *Metaphor is probably the most important of all the means by which language develops, changes, grows, and adapts itself to our changing needs*. When metaphors are successful, they "die" – that is, they become so much a part of our regular language that we cease thinking of them as metaphors at all." (Emphasis added.)

92. Colin Cherry, *On Human Communication: a Review, a Survey, and a Criticism*, 2nd edition. (Cambridge, Massachusetts: The MIT Press 1966), 74.

93. Cherry, 74, 75.

94. Dietrich Dörner, *The Logic of Failure: Why Things Go Wrong and What We Can Do to Make Them Right*, Translated by Rita and Robert Kimber, (New York, New York: Metropolitan Books, 1996), 153,154.

95. *Field Manual 101-5, Staff Organization and Operations*, (Washington, D.C.: USGPO, 1997) 5-1. *FM 101-5* begins its chapter on the MDMP in a similar description: "Decision making is knowing *if* to decide, then *when* and *what* to decide. It includes understanding the consequence of decisions. Decisions are the means by which the commander translates his vision of the End State into action."

96. *Field Manual 101-5*, 5-1.

97. Dörner, 157 – 160. Says Dörner, " the vastness of problem sectors prohibits us from investigating them completely, we must narrow our focus... there are many methods of narrowing our problem sectors ... [however] methods for narrowing problem sectors make methods for expanding them necessary too. Narrowing a sector lets us operate in a surveyable field, but the possibility exists that we are in the wrong one... there are several ways [to change our field]... Perhaps the most important method for expanding a problem sector *is thinking by analogy*." Dörner also says there are many techniques for narrowing a problem sector. He lists "hill climbing," "efficiency diversity," and "past success." "hill climbing" is associating a measurable variable [analogous to height] with your goal [analogous to a particular mountain peak] and acting in the "direction" of the goal as determined by that variable [analogous to going up – though the inherent danger here is that you could climb the wrong peak]. "Efficiency diversity" results from the selection of intermediate goals which will produce situations "favorable" in that from them there are more choices for future actions. "Past Success" is doing what worked before, but Dörner specifically warns planners against what he says Clausewitz called "methodism" – doing something only on the basis of its past success. In On War, Book 2, Ch. 4 "Method and Routine" (Methodismus in German), 152 – 155, Clausewitz discusses the pros and cons of blindly following what

amount to Standing Operating Procedures (SOPs). Dörner identifies several techniques of expanding the problem sector. He lists "free experimentation" (trial and error), "culling unsuccessful strategies" (not doing what failed in the past), and "thinking by analogy" (gaining understanding of the problem by relating it systematically to an analogous problem). However, Dörner also recognizes the practical limitations of various situations. On p. 161 he says, "In very complex and changing situations the most reasonable strategy is to plan only in rough outline and to delegate as many decisions as possible to subordinates."

98. If the metaphor comes to one individual from someone else such as in a "brain-storming" session, that communication is affective in Hayakawa's words, or effective transportation of meaning in Barzun's. Even if one achieves this understanding in isolation, the metaphor is the concept one has in mind *a priori* and from which one develops new beliefs. The author has carefully chosen the terms with which to describe this cognition. They are the same terms as are found in Immanuel Kant's 1787 description of "*a priori synthetic judgement.*" See Immanuel Kant, *Critique of Pure Reason.* Unabridged, edited and translated by Norman Kemp Smith. (New York, New York: St. Martin's Press, 1965), especially pp. 22 – 43.

99. John L. Casti, *Complexification: Explaining a Paradoxical World Through the Science of Surprise*, New York, New York: HarperCollins, 1994., 6-7; Wittgenstein is well known for his formulation of the linguistic theory of knowledge. According to this belief, one knows only what one can articulate using language. Casti references Wittgenstein's later work and claims it implies that one cannot use language to "'say' the link between the language and the real world." Rather, this link can only be "shown." It is a surprise to hear this from Wittgenstein because it seems to contradict the central idea of his theory. Rephrased by a linguist it would say that it is impossible to articulate meaning, which therefore implies that one *cannot know* the meaning – of anything. But another way to put it is: Language alone is insufficient to sustain meaning. Cognition is the faculty with which the mind derives meaning from language by contextual association with other informative symbols and emotive presymbols. So, says Casti, Wittgenstein changed his mind when he realized this. Also see Jagjit Singh,. *Great Ideas in Information Theory, Language and Cybernetics.* (New York, New York: Dover Publications, Inc., 1966), 4. Singh claims there are two "antipodal evaluations of the influence of language on ones' world view." The first is the Linguistic Philosophy in which "language is activity that is all but coterminous with life." The second is a Symbolic Philosophy such as that espoused by Sartre's hero Antoine Roquentin of La Nausée – in which language is merely a largely insufficient set of symbols used to represent objects. Says Singh, the truth is somewhere between the extremes of this dichotomy. In this light, Wittgenstein's later version falls nearer to the middle than to what Singh has called the Linguistic Philosophy.

100. Casti, 6-7.

101. According to *American Heritage® Dictionary of the English Language, Third Edition* by Houghton Mifflin Company.), Electronic version licensed from INSO Corporation. 1992): e·pis·te·mol·o·gy (î-pîs´te-mòl'e-jê) noun. The branch of philosophy that studies the nature of knowledge, its presuppositions and foundations, and its extent and validity.

102. Hayakawa,. 192 – 197.

103. Massimo Piattelli-Palmarini,. *Inevitable Illusions: How Mistakes of Reason Rule our Minds*, Translated by Massimo Piattelli-Palmarini and Keith Botsford, (New York, New York: John Wiley and Sons) 1994) 32. Piattelli-Palmarini is a Principal Research Associate at the Massachusetts Institute of Technology and the Director of Cognitive Science at the Institute of San Raffaele in Milan, Italy.

104. Piattelli-Palmarini, 32.

105.This is a general weakness to which all humans are evidently susceptible. Inductive arguments are chains of linked premises and propositions, many of which *cannot* be *absolutely* true. These can only be shown to be *likely* or *probably* true. Probabilities are mathematically expressible as fractions (less than one) and the probability of a conjunction is the product of the probabilities of its constituents. Therefore, "the probability of an entire [chain of inductive argument] being true is *always and without exception less probable than the probability of the least likely link in the chain.*" Piattelli-Palmarini calls this "the conjunction effect." Humans are evidently more likely to believe a conjunctive chain of argument, in which there are some probable links and some improbable links, than they are to believe the argument's individual improbable links. Most inductive arguments require multiple propositions to be true. For example: If and only if A and B, then C. If there is a ¼ probability that A is true, and a ½ probability that B is true, it is not mathematically possible for (A and B) and hence C to more likely than a 1/8 probability (the product of the probabilities of A and B). However, Piattelli-Palmarini demonstrates in several convincing examples that it is a general human weakness to believe that (A and B) is more likely than A. This occurs despite the mathematical *fact* that such conjunctions of premises and propositions make it *impossible* for the whole argument to be more likely true than its weakest links.

106.Peter M. Senge, *The Fifth Discipline: The Art and Practice of the Learning Organization.* (New York, New York: Doubleday, 1990) pp 139 – 269, especially pp. 174 and 175, also 274 and 275. Senge's discussion of individual visions built on mental models enables him to explain how groups can "dialogue" – openly share information about mental models and personal visions – to develop his idea of "shared vision" which then becomes the basis of cohesion in the learning organization. That this results from the interconnection of dialogue makes Senge's learning organization very much like what M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Chaos,* (New York, New York: Touchstone, 1992) calls a complex, adaptive, self-organizing system. (p. 11 and 280 – 299).

107.*Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C4) System Support to Joint Operations,* (Washington, DC: Joint Chiefs of Staff, 1995). In *Joint Electronic Library,* (Washington, DC: USGPO, 1997). I-4.

108.*Joint Pub 6-0, I-3.*

109.*Field Manual 100-5. Operations* (Final Draft). (Washington, D.C.: USGPO, 1997), 19-5. *Field Manual 100-6: Information Operations.* (Washington, D.C.: USGPO, 1996) 2-1.

110.Bloom, *Handbook II: Affective Domain,* 3.

111.Bloom, *Handbook II: Affective Domain,* v.

112.Bloom, *Handbook I: Cognitive Domain,* 7 and 201-207.

113.Bloom, *Handbook II: Affective Domain,* 7 and 176 – 185.

114.The description of generalized communications in this monograph is necessarily, quite superficial compared to those of Cherry, Pierce, and Singh (of utility in that order), as cited in bibliography.

115.Cherry, 217. Actually Cherry is rather absolute about this. He says simply that observation is not communication because it does not involve the use of a formal language. The generalized model developed for this monograph, does not disallow non-linguistic communication, however.

116.Jagjit Singh, *Great Ideas in Information Theory, Language and Cybernetics* (New York, New York: Dover Publications, Inc., 1966), 10. The diagram presented here is significantly modified. The definitions of terms in the paragraphs that follow represent a unification of the use of terms by Cherry,

Singh, Pierce. Of the three, Cherry gives the most consistent treatment: (Cherry, 111 – 123). The literature in general, is vague regarding the distinctions between the terms message, symbol, sign, and signal. Therefore, each of these is explicitly pictured and defined to lend clarity to the use of these terms throughout this monograph. The modified model also allows for a cognitive interpretation where the reception of the linguistic symbols yet requires a judgement of their meaning. The terms information, meaning, and knowledge are also ambiguous in the literature, so they are introduced in the clear context of the model.

117. In carrier modulation, a steady "signal" is transmitted and information is encoded as *variation* of the steady state of the signal. There are many techniques in actual use. The prototypical example is Amplitude Modulated (AM) radio – whereby the variation of the strength (amplitude) of the transmitter's carrier frequency (to which one tunes a receiver) is varied in proportion to the strength (amplitude) of an input signal – normally audio.

118. MS Office Internet Dictionary: **glean** (glên) verb gleaned, glean·ing, gleans verb, intransitive To gather grain left behind by reapers. verb, transitive 1.To gather (grain) left behind by reapers. 2.To collect bit by bit: "records from which historians glean their knowledge" (Kemp Malone). See synonyms at reap.

119. Webster's, 587. Also, MS Office Internet Dictionaŕy: "in·for·ma·tion (în´fer-mâ¹shen) noun Abbr. inf. **1**. Knowledge derived from study, experience, or instruction. **2**. Knowledge of a specific event or situation; intelligence. See synonyms at knowledge. **3**. A collection of facts or data: statistical information. **4**. The act of informing or the condition of being informed; communication of knowledge: Safety instructions are provided for the information of our passengers. **5** Computer Science. A nonaccidental signal or character used as an input to a computer or communications system. **6**. A numerical measure of the uncertainty of an experimental outcome. **7**. Law. A formal accusation of a crime made by a public officer rather than by grand jury indictment."

120. Myron Tribus, "Thirty Years of Information Theory," in Raphael D. Levine and Myron Tribus, *The Maximum Entropy Formalism*. Conference at Massachusetts Institute of Technology. (Cambridge, Massachusetts: The MIT Press, 1979), 11.

121. Tribus, 2. Tribus says that Shannon told Tribus that he wanted to call S "information" but that the word was "already badly overworked." Shannon quantified entropy as $S = -\Sigma p \ln p$ where Σ represents the indexed sum and p is the indexed discrete probability that any particular configuration of a system can exist (a function of the number of possible configurations).

122. Tribus, 4. However, a treatment in more depth is presented in Cherry, 213 – 217; Singh, 73 – 83; and Pierce, 78 – 105.

123. A detailed description of the math behind these statements is available in almost any college physics text. This particular description of entropy was developed after reviewing David Halliday and Robert Resnick, *Fundamentals of Physics*, Revised Printing, (New York, New York: John Wiley and Sons, 1974), 401- 417, esp. 411; and Feynman, Richard P., Robert B. Leighton, and Mathew Sands. "The Laws of Thermodynamics," in *The Feynman Lectures on Physics*. Commemorative Issue. (Redwood City, California: Addison-Wesley Publishing Company, 1989), 44-1 – 44-13 esp 44-10 and 44-11.

124. Edwin T. Jaynes, "Where Do We Stand on Maximum Entropy?" in Raphael D. Levine and Myron Tribus, *The Maximum Entropy Formalism*. Conference at Massachusetts Institute of Technology. (Cambridge, Massachusetts: The MIT Press, 1979), 16. Emphasis added.

125.Tribus, 7, and Jaynes, 31. Jaynes says, "Boltzmann's 'method of the most probable distribution,' [has] exactly the same mathematical content of the Principle of Maximum Entropy." There is actually a minus sign that is attached to the Jaynes formulation of entropy that does not appear in thermodynamic. However, that sign is necessary for the consistency because in thermodynamics energy is liberated as the system seeks equilibrium (its most uniformly distributed, most random, and therefore most probable state). In the information theory, however, as the system (message) is reduced toward its most random state, there is not "thing" that is liberated; what is liberated is the "capacity" of whatever is used to hold or carry the message (space on a page, access time on a network, etc).

126.Jean Pierre DuPuy, "Myths of Informational Society," in Kathleen Woodward, *The Myths of Information: Technology and Postindustrial Culture*. (Madison, Wisconsin: Coda Press, Inc., 1980), 13,14. DuPuy says there are two "standard limitations to Shannon's information theory: namely that it cannot account for the creation of information, nor for the significance of information."

127.J. R. Pierce, *Symbols, Signals, and Noise: The Nature and Process of Communication*, (New York, New York: Harper Torchbooks, 1961), 24.

128.Cherry, 114.

129.Cherry, 228.

130.Cherry, 228 and 233.

131.Heinz Von Foerster, "Epistemology of Communication," in Kathleen Woodward, *The Myths of Information: Technology and Postindustrial Culture*, (Madison, Wisconsin: Coda Press, Inc., 1980), 19.. Von Foerster presents some interesting ideas about collective behavior and communication, including a notion of "stable eigenbehaviors" and "bi-stability" which result only in systems where there is a recursive sort of bi-reference which he reduces metaphorically to "interaction becomes communicative if, and only if, each of the two sees himself through the eyes of the other... communication, ethics, and love converge into the same domain." (p. 27) Von Foerster's dis-affinity for the commodity model is easier to understand when one sees the overall message of Woodward's collection of papers. In general, each is a judgement that American society is bad and information theories that spring or support it are bad

132.1 **signal** [... LL, neut. Of signalis of a sign, fr. L signum] 1 archaic : token, indication 2 **a** : an act, event, or watchword that has been agreed upon as the occasion of concerted action <waited for the ~ to begin the attack> **b** : something that incites to action 3 **a** a sound or gesture made to give warning or command <a ~ that warns of an air raid> **b** : an object placed to convey notice or warning 4 : an object (as a flag on a pole centered over a point so as to be observed from other positions in surveying 5 **a** : an object used to transmit or convey information beyond the range of human voice **b** :the sound or image conveyed in telegraphy, telephony, radio, radar, or television **c** : a detectable physical quantity or impulse (as voltage, current, or magnetic field strength) by which messages or information can be transmitted 2 **signal** 1 : to notify by a signal <~ ed the fleet to turn back> 2 **a** : to communicate by signals **b** : to constitute a characteristic feature of (a meaningful linguistic form) ~ vi : to make or send a signal. 3 **signal** : [... of signaler to distinguish, fr. Olt segnalare to signal, distinguish, fr. Segnale, fr. ML signale] 1 : distinguished from the ordinary <~ achievement> 2 : used in signaling <~ beacon>

133.Marshall McLuhan, *Understanding Media: The Extensions of Man*, (New York, New York: McGraw-Hill, 1964), 7.

134.McLuhan, 8.

135.McLuhan, 22. "... hot tends to exclude, cool tends to include"

136.McLuhan, 22. Italics added. He uses the term "information" as a synonym for "data" and seems to assume that the quantity of data is the only thing that determines the "amount" or the impact of the *meaning* of the data.

137.McLuhan, 308, 336.

138.McLuhan, 90 – 91, also 95, 96. (emphasis added).

139.McLuhan, 97.

140.McLuhan, 103.

141.McLuhan, 247.

142.McLuhan, 267. McLuhan is also critical of the Shannon – Weaver style of information theories because they are "oblivious to the telephone as a form."

143.McLuhan, 306.

144.Martin Van Creveld, *Command in War,* (Cambridge, Massachusetts: Harvard University Press, 1985), 258 – 260.

145.Heinz Von Förster, "Epistemology of Communication," in Kathleen Woodward, *The Myths of Information: Technology and Postindustrial Culture*, (Madison, Wisconsin: Coda Press, Inc., 1980), 19.

146.E. B. Sledge, *With the Old Breed at Peleliu and Okinawa,* (New York, New York: Oxford University Press, 1981); S.L.A. Marshall, Men Against Fire: The Problem of Battle Command in Future War, (Glouster, Massachusetts: Peter Smith, 1978), and Anthony Kellett, Combat Motivation: The Behavior of Soldiers In Battle, (Boston, Massachusetts: Kluwer Boston, Inc., 1982).

147.Cherry, 20.

148.J. F. C. Fuller, *The Foundations of the Science of War*, (London: Hutchinson & Co. 1925. Reprint, Fort Leavenworth, Kansas: U.S. Army command and General Staff College Press, 1993) (page references are to the reprint edition), 200. Note though neither Spencer nor Fuller takes it so far, this "universal law of redistribution of matter" is an expression of the laws of thermodynamics. In fact the degree to which a society organizes beyond its "equilibrium" state is analogous to the "free" energy that entropy quantifies. Spencer is not the only one to have had thoughts along these lines. Tribus reports on page 9 of "30 Years of Information Theory" that Shannon's quantitative method has been applied to the study of social sciences: Kuhn, A. The study of Society – A Unified Approach. Homewood, Illinois: Irwin Dorsey Press, 1963. However, such an approach must conclude that entropy quantifies the order in society... it still tells one nothing about the role of information (communication) in the society.

149.The American Heritage® Dictionary of the English Language, Third Edition by Houghton Mifflin Company. Electronic version licensed from INSO Corporation. 1992

150.Cherry, 20.

151.Cherry, 22-24.

152.Cherry, 24-26.

153. This is an application of Cherry's concept of social field as opposed to network to Schneider's concept of disintegration in battle in "The Theory of Operational Art."

154. M. Mitchell Waldrop, *Complexity: The Emerging Science at the Edge of Chaos*, (New York, New York: Touchstone, 1992), 294 – 299. Waldrop's primary protagonist is Brian Arthur of the Santa Fe Institute (SFI). Arthur and others at SFI describe all system behaviors with one of four labels. In two of these types the behavior of the system is completely determined. First is those behaviors which converge to a single value. Second is those behaviors which are periodic. The fourth is behaviors that diverge to random configurations. The third seems to be between the second and fourth: behaviors that produce a new (emergent) order.

155. Martin C. Libicki, "The Small and the Many." In *In Athena's Camp: Preparing for Conflict in the Information Age*. RAND Publication MR-880-OSD/R. Edited by John Arquilla and David Ronfeldt. Santa Monica, California: NDRI, RAND, 1997. (also at http://www.rand.org/publications/MR/MR880), 191 - 211. "The Small and the Many," is excerpted from Libicki's *The Mesh and the Net: Speculations on Armed Conflict in a Time of Free Silicon*, Washington, D.C.: National Defense University Press, 1994, pp. 19–51.

156. Kevin Kelly, *Out of Control: The New Biology of Machines, Social Systems and the Economic World*. (Reading, Massachusetts: Addison-Wesley Publishing, 1994), passim, esp 400-401, 306- 311, 11-13, and 20-28.

157. Libicki, "The Small and the Many," 211.

158. Libicki, "The Small and the Many," 211.

159. James M. McPherson, *For Cause and Comrades: Why Men Fought In the Civil War*, (New York, New York: Oxford University Press, 1997), 109. McPherson implies that at the macro level, information (true or not) defines the direction of the collective effort. He contrasts the effect of the Emancipation Proclamation on Confederates and Union soldiers. Confederates were united against it. Union solders in general were not willing to make that a moral issue to die over.

160. Eric Hoffer, *The True Believer: Thoughts on the Nature of Mass Movement*, (New York, New York: Harper and Row, 1951), 46. See also other comments on the dynamic nature of cohesion: 45, 48, 76, 79, 93, 94, and leadership: 102, 105.

161. Corrielli Barnett, *The Swordbearers: Supreme Command in the First World War*, (Bloomington, Indiana: Indiana University Press, 1975), 73. (emphasis added).

162. Barnett, *The Swordbearers*, 75.

163. Barnett, *The Swordbearers*, 52.

164. Barnett, *The Swordbearers*, 60.

165. Casti, 139.

166. Anthony J N Judge, *Future Coping Strategies: Beyond the Constraints of Proprietary Metaphors*. (Apparently unpublished paper: http://www.uia.org/uiadocs/coping.htm, 1997), passim. **According to Judge,** "Faced with the complexities and challenges of the times, much effort has gone into the development of models and scenarios through which to comprehend the future and to guide the

navigation of policy-makers. Career advancements, and even Nobel Prizes, are strongly linked to the formulation of a model with competitive advantages over those generated by colleagues. This applies to the academic arena, corporate consultancy, and in the worlds of governmental and intergovernmental expertise. The challenge of developing coping strategies is not confined to governments, corporations or other collectivities, at whatever level of society. Strategic thinking is common to both collectivities and individuals." (p. 1) **The many sources include**: Guy Damian-Knight. *The I Ching on Business and Decision Making; a corporate, economic and political policy-making manual*. London, Rider, 1986; Howard Gardner. *Frames of Mind: the theory of multiple intelligences*. New York, Basic Books, 1983. David Gordon. *Therapeutic Metaphors; helping others through the looking glass*. Cupertino CA, Meta Publications, 1976; Ned Herrmann. *The Creative Brain*. Lake Lure NC, Brain Books, 1988; Anthony Judge. *Metaphor as an unexplored catalytic language for global governance*. Brussels, 1992; Dudley Lynch and Paul L Kordis. *Strategy of the Dolphin; scoring a win in a chaotic world*. New York, Fawcett Columbine, 1988; and many others. Note: "The Union of International Associations (UIA), [is] a nonprofit clearing house for information on over 20,000 international organizations and constituencies, has been a pioneer in the provison of information on international organizations and their global challenges since its foundation in 1910."

167. Judge, 8.

168. Judge, 4.

169. Magoroh Maruyama, "Information and Communications in Poly-Epistemological Systems," in Kathleen Woodward, *The Myths of Information: Technology and Postindustrial Culture*, (Madison, Wisconsin: Coda Press, Inc., 1980), 29. Maruyama's paper is primarily an exposition of the cultural difference between the west, of which he is highly critical, and Asia, which he praises. Viewing his information in the context of the other papers in Woodward's book as he indicates one should, the paper supports the understated political message of the book that American society is bad. Nonetheless, the paper has some very appealing features.

170. Maruyama, 34 – 39, and Waldrop 225-235, esp 228, 230, and 234. Also types of attractors for the four categories in Casti, 25 – 42, esp 26.

171. Arthur S. DeGroat, David C. Nilsen and the Advanced Warfighting Working Group, "Information, Combat Power and the Digital Battlefield," http://www.awwg.org/docs/awwgarchive/, 1996 (an abbreviated, edited version of this article appeared on pages 56-62 of the November-December 1995 issue of *Military Review*).

172. DeGroat and Nilsen, 2, 3.

173. James J. Schneider, "Black Lights: Chaos, Complexity and the Promise of Information Warfare," (Fort Leavenworth, Kansas: Revolution in Military Affairs Essay Contest, 1996), passim, esp. 6, - 9. (an edited version also appeared in *Joint Forces Quarterly* spring, 1997, 21 –28).

174. Schneider, "Black Lights," 7.

175. *The American Heritage® Dictionary of the English Language, Third Edition* copyright © 1992 by Houghton Mifflin Company. Electronic version licensed from INSO Corporation: "The principle that two particles of a given type, such as electrons, protons, or neutrons, cannot simultaneously occupy a particular quantum state. Also called *Pauli exclusion principle*"

176. Schneider, "Black Lights," 9, 13.

177. James J. Schneider, "Cybershock: Cybernetic Paralysis as a New Form of Warfare," Fort Leavenworth, Kansas: SAMS/USACGSC, 1995.

178. *Joint Pub 6-0, Doctrine for Command, Control, Communications, and Computer (C4) System Support to Joint Operations*, (Washington, DC: Joint Chiefs of Staff, 1995). In *Joint Electronic Library*, (Washington, DC: USGPO, 1997), I-4 and I-5.

179. *Joint Pub 6-0*, II-4.

180. *Joint Pub 6-0*, I-6.

181. *FM 100-5 (1997 Final Draft)*, II-2-1.

182. Fuller, 13 – 18. Fuller claimed to have deduced his original sets of principles directly from his study of Napoleon. He also claimed to be responsible for their indoctrination in Field Service Regulations in 1920 -- before he wrote *The Foundations of the Science of War*. As a "scientific" work however, he intended *The Foundations of the Science of War* to establish the legitimacy and credibility of these principles. His method was to identify fundamental dualities. In this, he was philosophical – or in fact metaphysical. He believed that the relationship between these polar extremes was just as important as the labels of the extremes themselves. Therefore, he grouped the two extremes and their relationship together as a "tri-unity." He called the idea of tri-unity the "threefold order." His prototypical triunity is from classical physics: inertia (pure resistance to acceleration) and energy (pure activity) are the extremes, and motion is the relationship. The physical "laws" of motion govern the relationship between inertia and energy. In the military environment, his prototype is man. The body and the soul are the extremes, and the mind is the relationship. The root of his development of the principles of war considers human activity: the extremes of exertion and resistance to force – the relationship is economy of force. Many examples of Fuller's threefold order are shown at appendix 3.

183. The 1993 Edition of US Army FM 100-5 says the US Army published its first discussion of principles of war in 1921, but it does not credit any sources of these principles. Further, the definitions of the principles in FM 100-5 are intended for general understanding with rapid reading, so they are somewhat vague and are not commonly understood by the US Army's membership.

184. Actually, it was apparently Christian Huygens who gave us the mass - kinetic energy relationship: $K = \frac{1}{2}mv^2$. See Harris Benson, *University Physics* (New York, New York: John Wiley and Sons, 1991). 144. Also thanks to Major Peter Laky, who taught physics with this author at the USMA, West Point NY in 1994 and 1995, for helping to research this fact. According to Benson, "In 1667 Huygens had found that the total value of the quantity mv^2 does not change when there is a collision between two hard balls. Leibnitz called it {italics} vis viva." According to Dr. Laky, "The thrust of Benson's treatment is that $K = \frac{1}{2}mv^2$ *follows* from the modern forms of Newton's laws and the modern definition of work" (though it is not *directly* attributable to Newton). Newton, to describe the relationship of mass and acceleration (and hence energy, by loose association) to Force, postulated his second law: $\Sigma F = ma$, and invented the calculus. Of course, Einstein's theory of relativity shook loose the foundations of modern science when it indicated mass - energy equivalence. Mass is the physical measure of an objects inertia and energy the physical measure of its activity – the two extremes of Fuller's duality are evidently physically equivalent.

185. James J. Schneider, "The Theory of Operational Art," *Theoretical Paper No. 3*. Second Revision (Draft), (Fort Leavenworth, Kansas: School of Advanced Military Studies, Command and General Staff College, 1988), 6 and figure 2.. Though the text of Schneider's draft (p. 6) specifically identifies the physical and moral domains, it only mentions "the cybernetic factor." However, he specifically pictures the

"cybernetic domain" in figure 2. Schneider's purpose in these pages is to relate the roles of the moral and cybernetic domains in maintaining (or losing) cohesion.

186. Fuller, 334.

187. Kevin Kelly, *Out of Control: The New Biology of Machines, Social Systems and the Economic World.* (Reading, Massachusetts: Addison-Wesley Publishing, 1994), 116.

188. L. F. Menabrea, "On the Mathematical Principles of the Analytical Engine." In *Cybernetics.* Edited by C. R. Evans and A. D. Robertson, (Baltimore, Maryland: University Park Press, 1968), 1.

189. Menabrea, 1.

190. Kelly, 116.

191. Kelly, 453.

192. Benjamin C. Kuo, *Automatic Control Systems*, Fourth Edition, (Englewood Cliffs, New Jersey: Prentice-Hall, 1982), 1 – 17, especially 5. The diagram is this author's interpretation of material from the first chapter of Kuo's book. Note that there may be many variations on the diagram. There could be several feedback signals, some of which are unintentional. There could be several different input signals, or several different controlled variables (such as position, speed, and acceleration in the example). Further, the entire controlled system could be embedded inside a larger controlled system. A conceptual example of this is human-operated (control level 1) power steering (control level 2). This layered control is a useful description of a chain of command.

193. Kenneth Allard, *Command, Control, and the Common Defense,* Revised Edition, (Fort Lesley J. McNair, Washington, D.C.: National Defense University, USGPO, 1996), 153.

194. Allard, 154.

195. Allard, 154 – 155.

196. Allard, 154 – 157.

197. Allard, 159.

198. Ronald N. Giere, *Understanding Scientific Reasoning,* (New York, New York: Holt, Rinehart and Winston, 1979), 337.

199. Giere, 305 - 337.

200. Casti, 12. Casti defines four criteria that a scientific hypothesis must meet before it can be considered a "rule." He says it must be *explicit, objective, public,* and *reliable.* Our hypothesis is explicit if it is unambiguously stated. It is objective if it is free of investigator bias. It is public if it is testable by anyone. Finally, if our hypothesis is repeatedly validated by many independent efforts – over a long period, we say it is reliable. It has stood the test of time, and we are justified in believing it as a "rule" or an element of our body of knowledge about the world. The criteria this monograph uses are designed to measure not only the justifiability of the metaphor, but also its general utility. In this monograph *public* and *objective* are incorporated by *commonality, explicit* by *ambiguity,* and *reliability* by itself. The other criteria used in this monograph serve to measure utility.

201.David Jablonsky, Professor of National Security Affairs at the U.S. Army War College, addresses change and trends in "The Owl of Minerva Flies at Twilight: Doctrinal Change and Continuity and the Revolution in Military Affairs", (Carlisle, Pennsylvania: US Army War College, May 1994), also at http://carlisle-www.army.mil/usassi/ssipubs/pubs94/owl.txt. Jablonski borrows from Robert Heilbroner, The Future as History, (New York: Harper & Row, 1960), pp. 193-197. "with change, there is usually continuity due to what Robert Heilbroner calls the 'inertia of history.' Inertia in this sense does not just mean resistance to change, but also what Heilbroner refers to as the 'viscosity' of history--the tendency of people to repeat and continue their way of doing things as long as possible." To clarify the Jablonsky-Heilbroner notion, one must understand that, in its essence, the statement means that the current trends (and the current changes in the current trends (and maybe even the changes in those changes)) will tend to continue in the future. Therefore, if the use of a particular metaphor grows suddenly, it is just as likely to continue to continue to grow rapidly as it is to suddenly wither. Things do not tend to suddenly appear and then continue steadily.

202.John E. Frame, *Core Functions: Useful Concept for Army Planning*, Student Monograph, (Fort Leavenworth, Kansas: SAMS,USACGSC, 1997), 13 – 21.

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